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TWINS *T* AND *C* FROM INFANCY TO ADOLESCENCE: A BIOGENETIC STUDY OF INDIVIDUAL DIFFERENCES BY THE METHOD OF CO-TWIN CONTROL*

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Mr. and Mrs. William Orbison very kindly made the meticulous Rorschach test analysis which will be referred to in the text. We are under obligation to Dr. Hubert S. Howe who placed at our disposal the results of his highly technical microscopic study of hair samples.

Finally and perhaps most fundamentally we are indebted to the twins themselves. From infancy to adolescence they have more than done their part. We can scarcely imagine two more delightfully cooperative subjects with whom to work.

ARNOLD GESELL
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I. INTRODUCTION

A. UNDERLYING DATA AND METHOD

Twins *T* and *C* have several times appeared in the literature of Child Development as subjects of experimental study by the method of co-twin control. This is a method of comparative investigation in which one of two highly identical twins is used to define the differential effects of specified factors confined to the co-twin. In fact, *T* owes her pseudonym to the fact that she has served as the primarily trained or stimulated subject in the experimental studies, while *C* has served as the comparative control. She continues to serve as the basic twin for control reference even when she is secondarily or differentially trained for purposes of comparative investigation.

The method of co-twin control has its origin in a stair-climbing and cube behavior experiment conducted when the twins were between 46 and 56 weeks old. The present study is the first long range biogenetic application of the same method to determine the stability of behavior resemblances and differences.

Through an exceptionally fortunate convergence of circumstances it has been possible to follow the development of these self-same twins from early infancy to puberty. The twins have remained ideal subjects for comparative study because their developmental opportunities have not been interrupted or distorted by any extreme illnesses or unusual events confined to one twin. For five years, while *in the first to fifth grades, they attended different classrooms and* came under the influence of different teachers, but otherwise their educational opportunities and avocational activities have remained substantially alike. During all these years they have maintained a friendly, interested, and coöperative relationship with the Clinic. This circumstance has facilitated detailed and intimate comparative estimates and has also enabled us to document their behavior with abundant motion picture records.

Emotional factors, which are extremely important in a long continuing biogenetic study, were kept under favorable control, due to the amiable temperament of the twins, their enjoyment of the experiences at the clinic, and the excellent coöperation of the parents, who appreciated the incidental guidance which was rendered. As already indicated, throughout these studies Twin *T* usually served as the primary trained twin. The circumstances and arrangements of the studies did not however result in any adverse kind of isolation of Twin *C*. The social and personality factors surrounding the whole series of studies were kept in a natural equipoise.

The purpose of this paper is to review the voluminous data which have accumulated and to subject the data including the cinema records to critical comparison. In this comparative review we have had substantial assistance from Mrs. Louise B. Ames. Although she was familiar with previously published studies, she had no personal contact with the twins until they were 12 years of age. Being free from personal preconceptions her comparative evaluations may be regarded as impartial.

Our present purpose goes beyond a mere descriptive summary of the observations which have accumulated. We have attained a vantage point where we can contemplate the entire mass of data in perspective and can benefit from the corrective evidence which only a long span of development can supply. We may consider the total growth careers of Twins *T* and *C* as a large scale experimental test of the stability of the similarities and differences which were first observed in infancy. The results of this long range "experiment" are embodied in the stenographic notes, ratings, characterizations, and cinema records made at more or less periodic intervals. Time tells. Our problem is to scrutinize and to appraise all these records in such a way that we may gain a better understanding of the genesis and the developmental patterning of correspondence and disparities.

The scope of the present monograph is indicated by the sectional headings listed in the table of contents and by the list of experimental studies and comparative observations summarized below.

We have introduced the twins by name; we might go further and give a preliminary indication of the fundamental differences which we believe to be characteristic of the twins. Our estimate of these differences has been based on a long inductive study over many years. It seems better to formulate this estimate at the end rather than at the beginning. We shall, therefore, present the facts in compact exposition, with a minimum of comment until we reach the concluding interpretive section. This will give the reader ample opportunity to build up his own unprejudiced inferences as he proceeds.

B. COMPARATIVE STUDIES OF TWINS *T* AND *C*

1. *Chronology of Data*

TABLE 1

Basic data code				Age	Special study or event.
				0	Born July 3, 1927.
				4 wks.	Mother died of septicemia.
				5 wks.	Transferred from Hospital to Child Caring Institution.
		*		6 wks.	
		*	*A*	8 wks.	
		*		15 wks.	
		*		16 wks.	
				19 wks.	Severe intestinal infection. Hospitalized for two weeks.
		*		24 wks.	
	C	*	*A*	28 wks.	
		*		32 wks.	
		*		36 wks.	
	C	*		38 wks.	
		*		40 wks.	
	C	*	*A*	42 wks.	
S				46 wks.	Gesell and Thompson. Learning and Growth in Identical Infant Twins. *Genet Psychol. Monog.*, 1929, 6, 1-124.
↑					
S	*C*	*	*A*	52 wks.	
↓					
S	*C*			54 wks.	Also, Thompson, H. The growth and significance of daily variations in infant behavior. *J. Genet Psychol.*, 1932, 40, 16-36.
	C	*		63 wks.	
S	*C*	*	*A*	79 wks.	
↑					
				89 wks.	Pyelitis (Twin *C*).
↓					
S	*C*			93 wks.	Strayer, L. C. Language and Growth. *Genet. Psychol. Monog.*, 1930, 8, 209-319.
	C	*	*A*	2 yrs.	
				2^2 yrs.	Transferred from Institution to parents' home.
S	*C*	*	*A*	2^6 yrs.	Unpublished observation of home behavior—language development —play — drawing behavior.
↑ ↓					
S	C	*	*A*	2^9 yrs.	(Miriam Partridge).
				2^{10} yrs.	Chicken pox.
	C	*	*A*	3 yrs.	
S				3^1 yrs.	Unpublished observation of motor characteristics—attentional behavior—and play.
↑ ↓					
S				3^5 yrs.	(Dura-Louise Cockrell).
		*	*A*	3^6 yrs.	

TABLE 1 (*continued*)

Basic data code				Age	Special Study or event.
S ↑				3^{7} yrs.	Personality Study. (Vernon Lytle and Maude Lytle). Also Thompson, Helen. The Modifiability of Play Behavior with Special Reference to Attentional Characteristics.
				3^{8} yrs.	Grippe.
↓				3^{9} yrs.	Measles.
S				3^{11} yrs.	End of personality study.
		*	*A*	4 yrs.	
S ↑	*C*	*	*A*	4^{6} yrs.	Hilgard, J. R. The Effect of Early and Delayed Practice on Memory and Motor Performances Studied by the Method of Co-Twin Control. *Genet. Psychol. Monog.*, 1933, **14**, 493-567.
		*	*A*	5 yrs.	
↓				5^{2} yrs.	Entered kindergarten. Both in same room.
S				5^{9} yrs.	
	C	*	*A*	6 yrs.	
				6^{2} yrs.	Entered first grade. In separate rooms.
	C	*	*A*	6^{6} yrs.	
	C	*	*A*	7 yrs.	
	C	*	*A*	7^{6} yrs.	
	C	*	*A*	8 yrs.	Half sister born.
	C	*	*A*	8^{6} yrs.	
	C	*	*A*	9 yrs.	
				9^{1} yrs.	Tonsillectomy (Twin *T*).
		*	*A*	9^{6} yrs.	
S				9^{9} yrs.	Battery of tests relating to reading (Marjorie Miles).
S				9^{10} yrs.	Otological examination. (Dr. Frederick Sperry).
				10^{2} yrs.	*Entered fifth grade. In same room once more.*
	C	*	*A*	10^{3} yrs.	
S				10^{10} yrs.	Personality observations. (Mary Hester Camp).
S ↑	*C*	*	*A*	11 yrs.	Observations on physical growth taken every four weeks.
				12^{1} yrs.	Menarche. (Twin *C*, six weeks later).
		*	*A*	13 yrs.	Vision tests. (Glenna Bullis).
↓	*C*	*	*A*	13^{4} yrs.	
S		*	*A*	14 yrs.	

S=Special study.
*=Developmental examination.
A=Anthropometric examination.
C=Cinema.

C. THE PROBLEM OF DEVELOPMENTAL CORRESPONDENCE IN TWINS

Monozygotic twinship does not in itself insure a high degree of developmental correspondence. Paradoxically enough, uni-ovular twinning may express itself in two contradictory end results. It may produce perfect symmetry even to the point of mirror imagery in highly identical twins, *or it may produce gross disparity.* Nowhere in the study of man do we find such complete duplication of individuality as among monozygotic twins and nowhere do we find also such profound and monstrous degrees of individual differences as among twins of monozygotic origin. This adds piquancy to the question of the origin even of minor and benign disparities.

In our study of *T* and *C* we have pursued differences with special diligence. But this very pursuit has brought us face to face with the resemblances. The permanence and the magnitude of discrepancies *can be adequately estimated only against a background of similarity.* This, indeed, is the reason why "identical" twins are such powerful touchstones for the study of developmental problems.

Experimental embryology draws no hard and fast line between genetic and epigenetic factors. A recent study (2) of another pair of identical twins *A* and *B* may be here cited to indicate the precision with which the genetic mechanisms operate. These twin girls at the age of 12 years presented a duplication of bilateral coloboma involving each of their four eyes. These colobomas were amazingly *alike in size, shape, position, and pigmentation.* Genetically each coloboma traced back to a defective closure of the fetal ocular cleft. If a single "environmental" adversity caused the notching of the optic cup (in an embryo approximately 7 mm. long) it must have operated coincidentally within an extremely brief and critical interval on four rapidly organizing structures which simultaneously reached identical levels of maturity. This is an excessively remote possibility. It is still more unlikely that four defects of as many choroids, so similar in size, outline, position and pigmentation, could *have occurred at different times in consequence of four separate* moments of infection, of irritation or of damage neatly directed at each of the four eyes. It is, however, conceivable that the original single zygote or the constitutive factors in the twin embryos, which already held the hereditary determiners of all four eyes, held also the specific factors (or mutations) which delimited the development of the choroid. Similar specific factors would likewise account for the persisting remnant of the left hyaloid artery and for the correspondences of the shape and refraction of the four eyes. These eyes *were derived from a single cell with one genetic constitution.*

The handwriting, the spelling, the misspellings, the block-building, and many other behavior patterns in Twins *A* and *B* showed striking resemblances. Are behavior resemblances, also configured by specific factors comparable to those which determined the colobomas? This question will arise again in the discussion of the psychological similarities of Twins *T* and *C*.

II. PHYSICAL DEVELOPMENT

In physical appearance the twins have been extremely similar from infancy to adolescence. Even persons who have had long contact with them occasionally mistake one for the other. It is hazardous to attempt to distinguish the twins on the basis of general appearance or even of general demeanor. It is safer to place reliance on a slight but discernible difference in a chin dimple or a tilt of the head, or *a hair ribbon!*

The measurements and observations which are summarized below suggest that the somatic resemblances are deep seated and may extend to chemical factors which control physical development, body build, and physiological processes.

A. Height and Weight

The absolute heights and weights of the twins are comparatively graphed in Figure 1. It will be seen that at every age, except at 3 years and 11½ years when the twins measured exactly the same height, *C* measured taller than *T*. The difference was more pro-

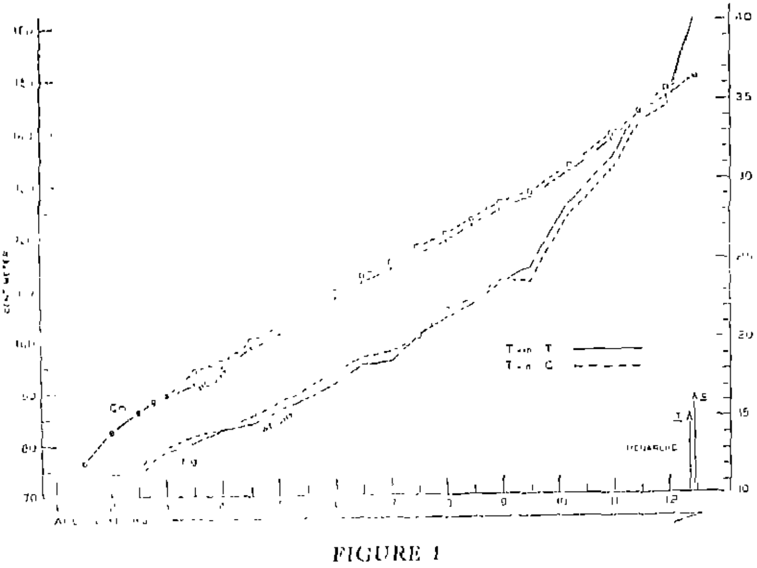

FIGURE 1

Comparative Height and Weight Chart for Twins *T* and *C* from 18 Months to 12 Years nounced when the twins stood, due probably to slight differences in posture. The difference in height was well defined at eight weeks and less pronounced though consistent up to three years when they measured the same. From 3 to 9½ years it decreased to about 0.5 cms., dipping to zero at 11½ years and then rising again. The dip at 11½ years is confirmed by repeated 4-weekly measurements taken between 11 and 12 years. It should be noted that a similar dip occurs in all longitudinal measurements. Any similarity in curves for longitudinal measures may or may not be significant. There is always the possibility that all longitudinal measures are influenced by the position of the child on the board. The measurements were made by the same person (H.T.) at each age, which reduced the personal equation error.

The difference between *T* and *C* in weight closely parallels the difference in height. Through nine years *C*, except on three occasions, weighed more than *T*. This difference would be expected since *C* was the taller. After nine years, with approaching adolescence, *T* became heavier than *C* and maintained the difference even after the menarche.

When the curves for differences in total length, suprasternal-sole length, and pubes-sole length are compared, *T*'s earlier acceleration at puberty will be noted. This accelerated growth occurred first in the pubes-sole segment, then in the suprasternal-sole segment, and lastly in the total length (cf., the curves between 10 and 12 years).

The difference curve for head length and breadth indicates that *T*'s head is consistently shorter and broader than *C*'s. The difference is, however, slight but definite since the error of measurement of these dimensions also is small.

The difference between *T* and *C* in head girth and chest girth is variable. Head girth was affected by hair cut, and chest girth was affected by breathing. However, the drop in the difference curve for chest girth between 9 and 12 years probably does reflect the earlier mammary growth in the case of *T*.

Breadth differences do not seem to be consistent except with respect to the iliocristal diameter after the age of five years when *C*'s pelvis is consistently broader at its maximum than *T*'s pelvis.

B. PALM AND FINGER PRINTS

In the first publication describing the physical similarity of *T*

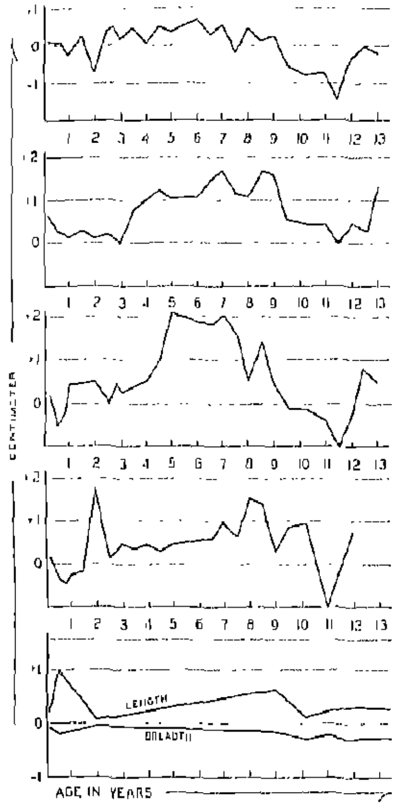

FIGURE 2

Differences in Physical Measurements Plotted in Centimeters: *C* Minus *T*

For the following measurements: weight, length, suprasternal-sole length, pubis-sole length, head length and breadth.

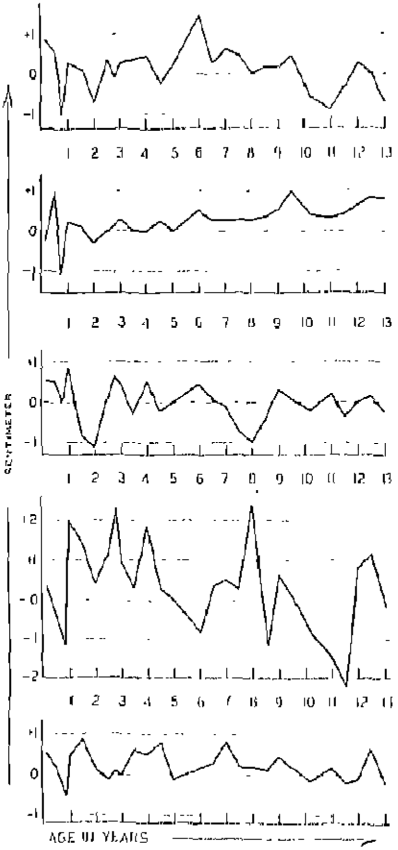

FIGURE 3

Differences in Physical Measurements Plotted in Centimeters: *C* Minus *T*

For the following measurements: biacromial diameter, bicristal diameter, chest breadth, chest girth, head girth.

and *C* (3) tracings were reproduced of their palm prints taken at the age of 18 months. Recently when the twins were 12 years and 9 months old, finger prints as well as palm prints were made. (Naturally the patterns are now more clearly defined and traceable. A slight error made in tracing the main lines from *T*'s and *C*'s middle and little fingers of the left hand in the former publication is exposed. The lines do not really merge but end in Spaces 5 and 9 as pictured in Figure 4).[1] The tracings which are here reproduced describe more completely than any formula the outstanding characteristics of the line patterns. The similarity is truly remarkable. It is interesting to note that the lines of the right palms are more similar than those of the left palms, but that the finger prints of the left hands are more similar in pattern than those of the right hands. Actually all of the differences are very minor ones.

When the twins were 6½ years old several leuconychia guttata (white specks on the finger nails) were noticed. Inspection and comparison of these marks on *T*'s and *C*'s nails showed unusual similarity with respect to their distribution on the various digits. (Table 2).

TABLE 2

NUMBER OF LEUCONYCHIA GUTTATA ON *T*'S AND *C*'S DIGITS

	T	*C*
Right thumb	None	None
Index finger	? 1	None
Middle finger	2	2
Ring finger	8 or more	5
Little finger	? 1	? 1
Left thumb	None	None
Index finger	1	1
Middle finger	1	7
Ring finger	5	1
Little finger	1	None

C. DENTITION

During their first year *T*'s and *C*'s dental growth was highly similar. *T*'s first tooth came slightly before *C*'s, but *C*'s second tooth was visible earlier than *T*'s. During the next 17 weeks denti-

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[1] The designation cited by Wilder and Wentworth, *Personal Identification: Methods for the Identification of Individuals Living or Dead.* Boston, Mass.: Gorham Press, 1918. Pp. 374.

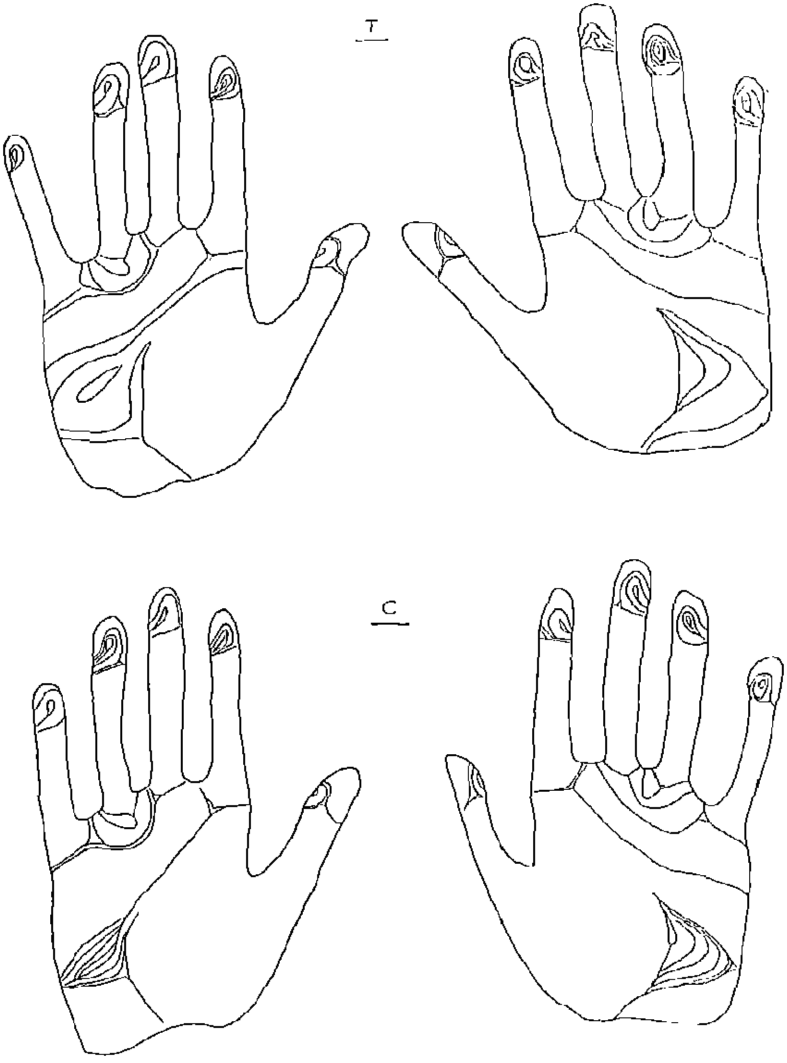

FIGURE 4

Friction Ridges of Palms of Twins *T* and *C*: (age, 12 years 9 months)
Mapped by Wilder and Wentworth's method.

Formula left palm, Twin *C*: 9-7-5-5.
" " " Twin *T*: 9-7-5-5
" right " Twin *C*: 11-9-7-5.
" " " Twin *T*: 11-9-7-5.

tion was slightly more advanced for *T*, but between the ages of 69 and 79 weeks, *T* acquired only one tooth while *C* acquired six, bringing *C*'s total above that of *T*.

The subsequent record of eruption of the deciduous teeth is incomplete; just when the six-year molars erupted is not known. It was after the age of seven years and prior to nine years.

With respect to the other permanent teeth, *T*'s development was definitely in advance of *C*'s. Exceptions were rare: the only permanent tooth of *C* which erupted before *T*'s corresponding tooth was the upper left first premolar; the only two teeth of *C* which were lost earlier than *T*'s corresponding teeth were the lower left incisor and first molar. The difference in dentition was most apparent at 12 years when *T* had five more erupted or partially erupted permanent teeth than *C*. Between 8½ and 11⅔ years every examination revealed either that *T* and *C* had the same number of teeth or that *T* had one more tooth than *C*. Between 11⅔ and 12 years *T* acquired five permanent teeth, *C* acquired none; it was not until the age of 12½ years that *C* had the same number of permanent teeth that *T* had at 12 years.

As far as we know, the order of eruption of the first 12 permanent teeth was identical for the two children, and there were only slight differences in the eruption order of the remaining eight teeth.

The upper teeth of *T* tend to erupt before the corresponding lower teeth, except in the case of the right canines and lateral incisors. The upper teeth of *C* likewise tend to erupt before the corresponding lower teeth, except in case of the right canines, lateral and central incisors, and left canines. In seven instances order of dentition for the twins was identical, in six instances order of dentition was uncertain, in three instances *T*'s order was advanced, in four instances *C*'s order was advanced.

The only anomaly of dentition occurred in *T*. Her left upper first premolar erupted exterior to the canine and at first was mistaken for the canine. Dentition is charted in Figure 5.

There is a slight difference in occlusion. *C*'s central incisors meet exactly, but *T*'s upper central incisors overlap the lower incisors. This difference is evident in their profiles. *T* has the more receding lower jaw.

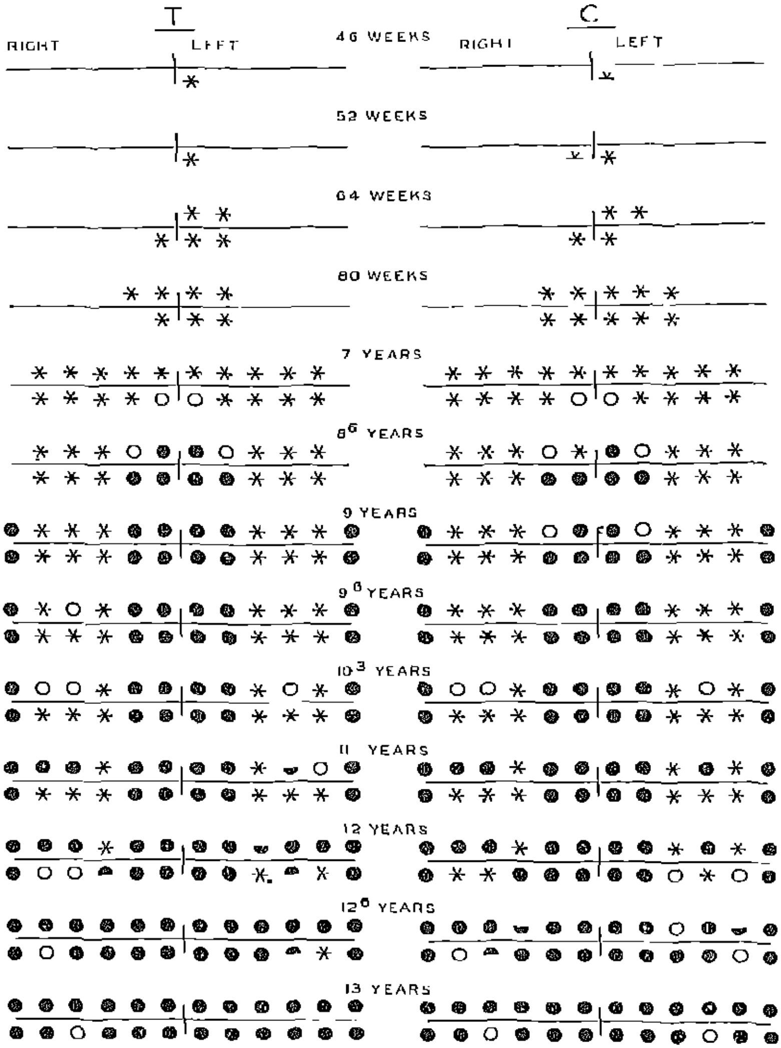

FIGURE 5

Comparative Chart of Dentition from 46 Weeks to 13 Years of Age

Key: *=deciduous tooth.
0=tooth out.
●=permanent tooth.
◒=tooth partly erupted.

D. HAIR AND EYE COLOR

Hair and eye color have been remarkably similar. Occasionally slight differences were recorded when the twins were compared separately with the hair and eye charts. Fischer's hair color samples and Martin's samples of glass eyes were used. These differences were found to be false when the twins were compared directly, which incidentally illustrates the precision of the method of co-twin control.

T's hair has a greater tendency than *C*'s to part on the left, and it grows a little more rapidly and has less tendency to curl in the middle of the forehead. Except at three years when *T* had her hair parted on the left and *C* had her hair parted on the right, their hair has been similarly styled. But *C* parts her hair higher than *T*, possibly to cover a more well defined left cowlick. The crown whorl of Twin *T* was noted in infancy to be clockwise, in Twin *C* counter-clockwise. This difference may be related to *C*'s forehead curl.

Hair and eye color records from 5 to 11 years are shown in Table 3.

TABLE 3

COLOR OF HAIR AND OF EYES

Age	Hair *T*	 *C*	Eyes *T*	 *C*
5 yrs.	*L*	*L*	Same as *C*.	2*A*, dark rim at outer iris and a little brighter around center.
6 yrs.	*L*	*K*	Same as *C*.	1*B*, dark rim at outer iris.
7 yrs.	*C*→*H* on left to *F*	(top) *D*→*K*	Same as *C*.	2*A*, streaks. More like 1*B*, dark rim at outer iris.
8 yrs.	*M*, *L* on ends	*L*, *J* on ends	Same as *C*.	4*A* or 1*B* and less white, red flakes.
10^a yrs.	*B*→*K*	*B*→*K*	Same as *C*.	2*A* but lighter c̄ dark rim, almost as light as 1*B*
11 yrs.	*J* or *P*	*J* or *P*	Same as *C*.	Lighter than 2*A*. More like 2*A* than *B*.
	Tends to grow a little faster.			

E. MICROSCOPIC EXAMINATION OF HAIR SAMPLES

A microscopic study of hair samples taken when *T* and *C* were 42 weeks old and again when they were near 13 years of age is summarized in Table 4.

TABLE 4

Diameters		
42 weeks	*T:*	The diameters of different hairs vary from .0175 mm. to .0467 mm. The average diameter of ten hairs is .0319 mm. The length is 15 to 30 mm.
	C:	The diameters of different hairs vary from .0126 mm. to .0534 mm. The average diameter of ten hairs is .0316 mm. The length varies from 20 to 30 mm.
12 yrs. 10 mos.	*T:*	This hair when examined under the stereoscopic microscope is shown to be somewhat flattened, the short diameter being 1/3 of the long diameter. Diameters vary from .048 mm. to .077 mm. Average of ten hairs, .063 mm.
	C:	Under the stereoscopic microscope the hair is seen to be flattened with the short diameter about 1/3 of the long diameter. Diameters vary from .033 mm. to .075 mm. with an average of ten hairs, .0582 mm.
Cuticle		
42 weeks	*T:*	The cuticle is similar in appearance to that of *C*, and has an average breadth of 0.01 mm.
	C:	The cuticular scales are unequal in breadth, but average 0.01 mm. The exposed edges are irregularly serrate, and in some instances very convex.
12 yrs. 10 mos.	*T:*	*The cuticle is in every way similar to that of C at the same age.* The average cuticular breadth is 0,0090 mm.
	C:	The cuticular cells are of more equal breadth than in the hair of 42 weeks. The average breadth is 0.0086 mm. The margins of the cells are irregular and serrate but in most instances not as convex as in the hair of 42 weeks.
Medullary Structure		
42 weeks	*T:*	About three-fourths of the hairs possess medullary structures. They are discontinuous but consist of islands varying in length from that of the diameter of the hair to four or five times this length. All medullary structures are dark in color and are not translucent. The largest diameter of the medulla is 1/6 that of the hair.
	C:	Medullae are present in about 1/4 of the hairs examined. When present its largest diameter is 1/6 of the total diameter of the hair. It is nowhere continuous and is made up of small strips varying in length from the diameter of the hair to about twice this length. Practically all of the visible medullary structure is dark in color and not translucent.

TABLE 4 (*continued*)

12 yrs. 10 mos.	*T:*	Most of the hairs show medullary structure but it *is much more broken and discontinuous than in the case of C.* By far the greater part is translucent and light in color. The broadest medullary diameter is 1/6 that of the hair.
	C:	Most of the hairs possess medullary structure which is present throughout the length of the hair, but frequently interrupted. In the main it is translucent but some areas are dark and do not transmit light. The largest diameter is 1/6 that of the hair.
Tip and Root of Hair		
42 weeks	*T* and *C:*	The tips of the hair of both *T* and *C* are blunt and normal for human hair. The bases have been cut and no roots are present.
12 yrs. 10 mos.	*T* and *C:*	Both ends of the hairs of both have been cut in the specimens furnished.
Color and Disposition of Pigment		
42 weeks	*T* and *C:*	The hair specimens of both show few granules which are light in color and of equal size and distribution.
12 yrs. 10 mos.	*T* and *C:*	The pigment granules in the hairs of both are entirely similar in color, size and distribution.
Summary	*T* and *C:*	The hair specimens of *T* and *C* at 42 weeks and at 12 years 10 months are very similar in all particulars. It is possible that in examining large numbers of hairs from each child it would be possible to identify the hair of each child at the same age, on account of the differences in medullary structure noted before. However these differences are within the normal range of variation.

F. VISION

On February 24, 1937, when *T* and *C* were 9½ years old, their vision was tested by the Betts *Ready to Read Tests.* The results indicated complete normality for both except in visual fusion. *T*'s far point fusion was normal but *C*'s was questionable. *T*'s near-point fusion was questionable and *C* failed the test. The tests for oculomotor and perception habits showed no constant difference.

Tests of vision were repeated at the age of 13 years, 3 months. Again their performance was remarkably similar. The following differences in visual function were noted:

On lateral imbalance *T* converged slightly more than *C* at the near point.

TABLE 5

BETTS TESTS OF OCULOMOTOR AND PERCEPTION HABITS

	Score for *T*	Score for *C*
Gross binocular vision		
Word orientation 1	20	20
2	20	20
3	20	17
Letter orientation	26	28
Number orientation	20	20
Superimposition		
Word orientation 1	19	20
2	20	19
Stereopsis		
Word orientation 1	20	20
2	15	19
3	17	17

On the fusion test at the near point, both over converge with the 2 mm. balls; *T* fuses the 6 mm. balls, *C* the 8 mm. balls. At the far point *T* was able to fuse the 2 mm. balls after delay while *C* failed to do so.

The greatest difference is on the duction test. *T*'s abduction is good. *C* shows poor abduction although the ratio of break and recovery is about the same as for *T*. In adduction *T* definitely surpasses *C*. She is able to hold to 60 and recover at 20. Although this recovery is slow, it is higher than for *C*. *C* cannot hold as long as *T*, breaking at 38, and her recovery is very slow (6).

There is very little difference in focus. *T* again, however, is slightly more accurate than *C*. *C* delayed in responding when she reached a letter she could not distinguish and it was necessary to tell her to go on to the next. *T* gave her responses whether correct or not.

T's pursuit fixation was smooth both binocularly and monocularly *C*'s binocular pursuit was best but there were slight irregular movements in both temporal regions. Monocularly the jerking was evident in the nasal regions in both eyes. Tested at 8½ years, *T* used the left eye in the Miles *V*-scope; *C*, the right.

G. HEARING

When the twins were 9½ years old their hearing was tested. The first test was made at the American School for the Deaf, West

Hartford, Connecticut, on February 24, 1937. A Sonotone *Audiometer* was used. This test showed a perceptible loss of hearing in both twins: *T*'s per cent loss through the speech range was 12 per cent for the left ear and 14.4 per cent for the right ear. *C*'s hearing loss was greater: 24 per cent for the left ear and 22.4 per cent for the right ear.

The twins were given a complete otological examination on April 30, 1937. Before testing the children the physician carefully cleared the nasal and auditory passages of any obstructions. A large plug of wax was removed from *C*'s left ear and a smaller plug from her right ear. *T*'s ears were found free from wax. Hearing tests

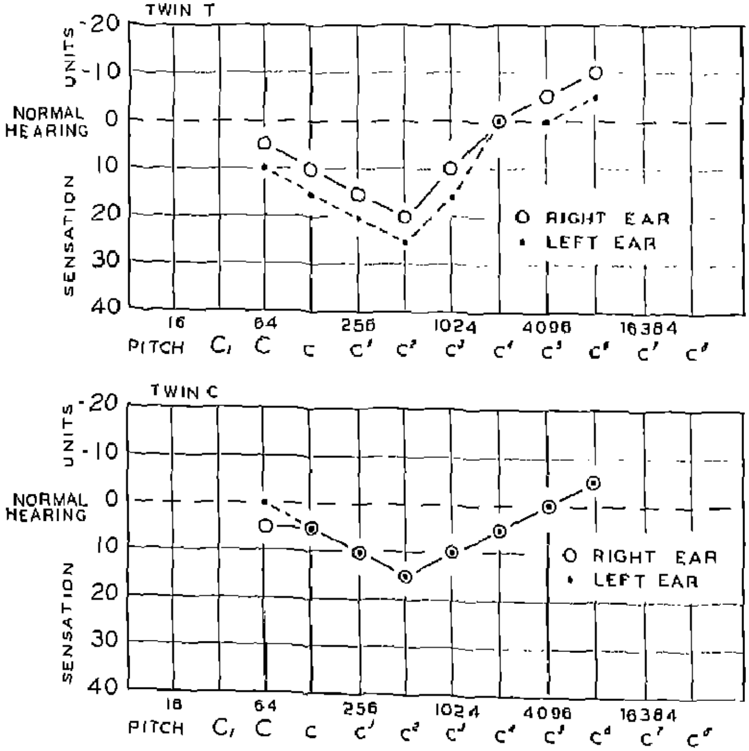

FIGURE 6

WESTERN ELECTRIC AUDIOGRAMS OF TWINS *T* AND *C*

(Age: 9 years 9 months.)

were then administered, using the Western Electric Audiometer. *Both children were then found to have normal hearing* (See Figure 6). *T*'s per cent loss in the speech range was 8 per cent for the left ear and 10.6 per cent for the right ear; *C*'s per cent loss in this range was 8 per cent for both ears.

The chart representing the hearing loss at different frequency vibrations is very similar for the twins. There is no way of knowing how long wax had been embedded in *C*'s ears. Probably it was there at the time of the first test, in which case it might account for the greater loss of hearing shown at that time. It is to be noted that *T*'s results on the two consecutive tests are quite similar.

H. HEALTH HISTORY

At the age of 19 weeks both twins were admitted to a hospital with a diagnosis of acute intestinal intoxication. *C* alone, at this time, suffered an attack of otitis media followed by pyelitis. At 84 weeks both children had an upper respiratory infection, from which *T* apparently recovered more slowly than *C*. At 89 weeks, *C* was confined to her crib with a kidney infection. After the twins were established in their home, *T* continued to be in somewhat poorer health. During a period of six months she was ill in bed with a temperature of 104° for two or three days, ate poorly and had relatively poor muscular tone, and had a sty on her left eyelid; she also *had reverted to sucking her thumb. During this same period C was* in excellent spirits and ate with appetite. On occasions she showed lapses of bladder or bowel control, whereas *T* showed control.

At 2 years, 10 months, both developed poor appetites and contracted chicken pox. *T* was sicker than *C*. At 3 years, 2 months, *T had a cold; C escaped although she slept in the same bed with T*. At 3 years, 9 months, both contracted grippe from their mother. At 3 years, 9½ months, both twins had simultaneous colds followed by simultaneous measles. After recovery, at 3 years, 11 months, *T* had another upper respiratory infection.

Physical examination at 5 years, 4 months, showed that *T*'s tonsils were considerably enlarged, but they were not removed until she was nine years old. In the meantime she was subjected to many colds and sore throats. *C*, on the other hand, remained in apparently better physical condition.

I. Eating and Sleeping Behavior

On fourteen occasions between the ages of 18 months and 12½ years *T* and *C* have lunched with us at the time of their clinic visit. Usually they finish eating at about the same time. On six occasions *C* has finished more quickly than *T*; the reverse was never noted. On three of these occasions it was observed that *T* ate faster at first and then dawdled, while *C* maintained a more even tempo of eating.

Normally both children have good appetites with no real food aversion. *T* dislikes beans and shallots while *C* dislikes peas and potatoes. *C* is occasionally upset by carbonated drinks. *T* tends to be chilled by drinking ice cream sodas, while *C* notices no effect.

From the time *T* and *C* left the Children's Home they shared a bed. Our first observation of their sleep was at the age of 33 months when they were at the Clinic. Put in separate cribs for their noonday nap they cried so lustily that they were placed together. *T* fell *asleep first but was aroused by C's restlessness. A home report indi*cated that this was customary, but at the age of 4 years, 9 months, their behavior in this respect was reversed. *C* then went to sleep more quickly while *T* was more restless. At both six and seven years while napping at the Clinic *C* was less restless than *T* and went to sleep more quickly. At 12½ years it was reported that *T* got tired more quickly. One evening she fell asleep in her chair, since she was unwilling to go to bed alone.

The above sleep behavior is undoubtedly intimately related to physical health. Our records do not suggest any consistent personality differences in sleeping habits.

J. Puberty

Twin *T* reached the menarche six weeks earlier than Twin *C*. This is in keeping with the fact that *T*, the shorter, stockier twin is slightly advanced over *C* in general physical maturity. At first *T*'s flow was more scant than *C*'s, her periods longer and more frequent and more irregular. Although the study is not yet complete, it is evident that *C*'s periods are establishing regularity earlier than *T*'s. At present *T*'s periods tend to last seven days; *C*'s periods, six days.

K. Biochemical Similarities

The close correspondences in pubescence suggest underlying similarities in biochemical constitution. This similarity was most strikingly demonstrated in the reaction of the twins to an undubitably simultaneous infection which they suffered at the age of 19 weeks. This particular episode was so dramatically staged for comparative observation that it should be considered as a revealing experimental test; one which was not designed but was so instructive that it deserves to be detailed.

On November 2, 1927, both children were vaccinated on the thigh. A week later they began to have several green watery stools daily. On the 13th, the condition of the children simultaneously became acutely worse, with symptoms of drowsiness, ashen pallor, sunken eyes, and extreme dehydration. They were admitted to a *hospital with a diagnosis of acute intestinal intoxication.* A total of 400 cc. saline was given immediately subcutaneously and intraperitoneally. Intravenous glucose was given at the same sitting: 65 cc. to Twin *T* and 75 cc. to Twin *C*. The following day 300 cc. saline was given subcutaneously. The symptoms cleared and the sudden improvement in appearance of both twins was little less than remarkable. Their course of convalescence was similar with one exception presently to be noted.

TABLE 6

TEMPERATURES OF TWINS *T* AND *C* (AGE 18-21 WEEKS)

The table lists the highest and lowest temperature (centigrade) recorded *each day and the range of temperature for each day.*

	Twin *T*			Twin *C*		
Nov.	*L*	*H*	*Diff.*	*L*	*H*	*Diff.*
8	37.78			37.66		
9	38.22			39.33		
11	37.00			37.78		
12	38.33			38.89		
13	38.00		0.	38.5	39.0	.5
14	38.0	39.0	1.	36.2	39.4	3.2
15	36.6	38.2	1.6	36.4	39.2	2.8
16	36.2	37.4	1.2	36.4	37.4	1.0
17	36.8	37.2	.4	37.0	37.4	.4
18	37.0	37.6	.6	37.0	37.4	.4
19	36.5	37.2	.7	36.4	37.4	1.0
20	37.0	37.6	.6	36.8	37.6	.8
21	36.8	37.8	1.0	36.8	37.8	1.0
22	37.0	37.2	.2	36.8	37.4	.6
23	36.8	37.6	.8	36.6	37.4	.8
24	37.0	37.4	.4	37.0	37.6	.6
25	36.8	37.6	.8	37.0	38.4	1.4
26	37.0	37.4	.4	37.4	38.2	.8
27	36.8	37.4	.6	37.0	37.4	.4
28	37.0	37.6	.6	37.0	37.8	.8

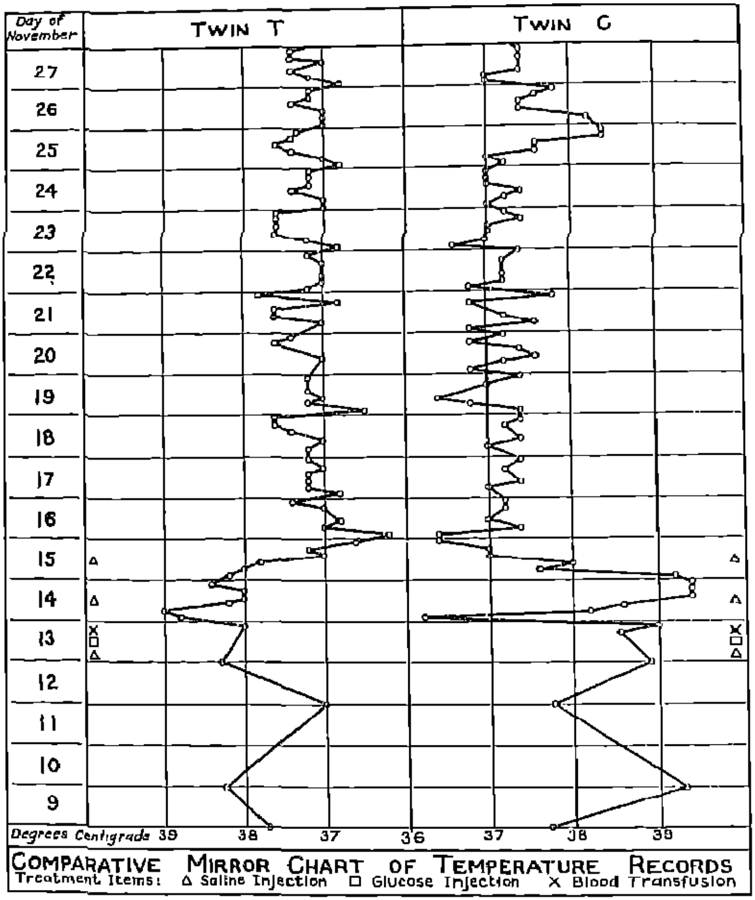

FIGURE 7
TEMPERATURE READINGS DURING A TWO WEEK PERIOD OF ILLNESS
(Age: 19 to 21 weeks.)

Physical examination on admission to the hospital showed both vaccination lesions to be in a similar encrusting stage. The children were highly comparable. Twin *C*'s temperature on admission was somewhat higher than Twin *T*'s. *T*'s pharynx was clear; *C*'s was slightly infected, her nose showed an old discharge, and her ear drums a margin of reddening. This condition culminated in a frank bilateral otitis media of the suppurative type in *C* on the 25th of November, associated with a slight loss of weight and with a sharp rise of temperature. The temperature subsided on treatment.

Since temperature regulation is an important homeostatic function, the accompanying comparative table of temperature readings becomes of some interest. This table indicates the highest and lowest temperature record each day, and the daily range of temperature. Twenty such determinations were made for 20 successive days. Seventeen readings show variations of less than 1°; three daily readings show no daily variations at all; eleven show variations of ½° or less. All of these discrepancies are in favor of Twin *T* who escaped the complication of acute otitis media. The remarkable similarity in the temperature readings for the twins is illustrated in the comparative mirror chart (Figure 7).

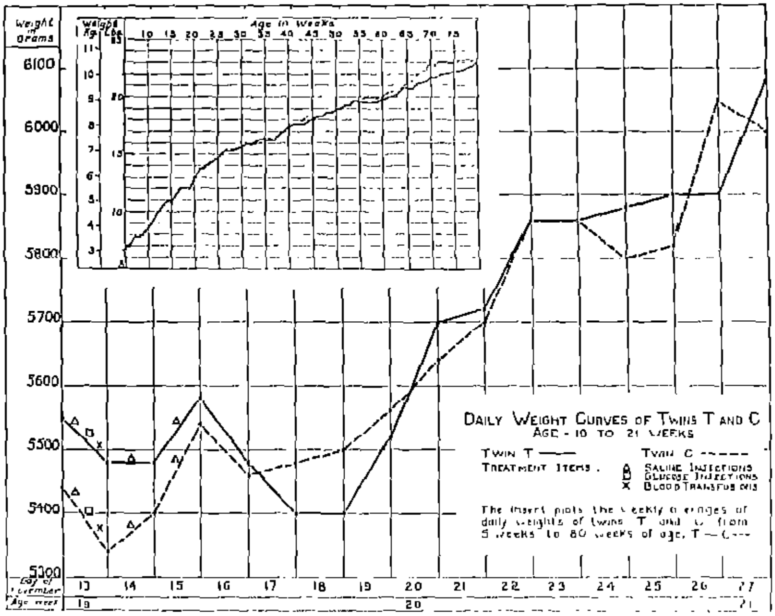

FIGURE 8

COMPARATIVE CHART OF WEIGHT CURVES DURING TWO WEEK PERIOD OF ILLNESS (Age: 19 to 21 weeks.)

The weight charts for the two children during the period of their illness show an equally impressive trend toward similarity (Figure 8). Even under the stress of an extremely threatening infection and under the strain of its heroic treatment, the twins made similar weight gains. *On two days, namely the 22nd and 23rd, they weighed exactly alike!* Such astounding indications of metabolic parity signify the presence of deep-seated biochemical correspondences which in these twins have projected themselves on an extensive scale into the detailed configurations of behavior patterns.

III. MOTOR BEHAVIOR

A. Postural Demeanors

The term motor demeanor refers to characteristic postural attitude and to distinctive manner of movement. Similarities of demeanor, in this sense, are so numerous for Twins *T* and *C* that to specify them would be an endless task. It is the sum total of these innumerable demeanors which make them look so much alike, and which make them *seem* so similar in deportment.

Only a few constant differences have been noted. When these are later subjected to interpretation, both somatic and environmental factors must be considered. Even then it may not be clear why *C* should have a slightly deeper chin dimple than *T*.

1. *Motor Tonicity*

In infancy *T* was slightly more advanced in postural activity than *C*. *T* was the first to roll over, to stand, to walk (13 days sooner), and to stand on one foot. In spite of this discrepancy, differences in postural attitudes were virtually indistinguishable. Similarity of facial expression appears repeatedly in the early photographic records.

As the twins grew older, a few differences in postural attitudes which are still characteristic became evident. *C*'s face is the more relaxed; she has a dimple in her chin deeper than *T*'s. *T* puckers her chin when smiling; and tends to hold her mouth slightly open while *C* holds hers closed. *T* tends to have a slightly more sober expression than *C*.

On the whole *C* maintains better and more symmetric body posture. *T* is likely to lower her head while *C* holds hers more erect. On joining hands, regardless of relative position, *T* places her hand pronately in *C*'s supinated hand.

In general *T* shows more body tension when posing for pictures. She is more likely than *C* to clench her dress or to assume a slightly stilted pose and expression. When body length (total reclining length) was measured the assistant always found that it was harder to hold *T*'s feet against the anthropometric board.

In general, *T*'s nervous tension is more evident in the skeletal musculature, while *C*'s nervous tension may express itself in the smooth muscle system. *T* is posturally more alert than *C*. *C* is more prone to gastric upset, and had more difficulty than *T* in acquiring bowel and bladder control.

2. *Writing Postures and Writing*

Marked and consistent differences in the writing posture of the twins are observable from 7 years, when the first cinema is available, through 12 years. Table 7 illustrates these differences. *T* leans to the left over her left forearm, tilts her head to the left, and writes with her paper in a slant alignment. *C* sits straight, holds her head straight, for the most part lets her left arm hang down at her side, and writes with the paper in straight alignment. Although each writes with the right hand, these differences in penmanship posture may be attributed in part to differences in laterality, which will be presently considered.

TABLE 7

DIFFERENCES IN WRITING POSTURE

Age:	7 yrs.	8 yrs.	9 yrs.	10 yrs.	11 yrs.	12 yrs.	13 yrs.
Body posture							
Straight		*C*	*C*				*C*
Leans slightly left	*C*		*T*	*C*	*C*	*C*	
Leans way left	*T*	*T*		*T*	*T*	*T*	*T*
Head posture							
Straight	*C*	*C*	*C*	*C*	*C*	*C*	*C*
Tilted left	*T*	*T*	*T*	*T*	*T*	*T*	*T*
Position of free arm							
Hangs down at side		*C*		*C*	*C*	*C*	*T*
Finger tips or wrist on table	*C*		*C*	*T*			
Whole forearm on table	*T*	*T*	*T*		*T*	*T*	*C*
Position of paper							
Straight	*C, T*	*C*	*C*	*C*	*C*	*C*	*C*
Top slanted to left		*T*	*T*	*T*	*T*	*T*	*T*

Differences in the handwriting products of the two girls, consistent with the differences in their postures, are observable from 7 to 12 years. For the most part *T* tends to write with an even slant to the right. Her final letters slant up, rarely down. Her writing does not vary greatly in size from year to year except at 10 years when it becomes quite large. *C* on the other hand writes more vertically. Her writing is uneven, both in outline of letters and as to size from age to age, being very large at 7 years, very small at 8, large at 9, very small at 9½, large again at 10 and 11 years. Final letters slant now up, now down. Her letters are for the most part less well-formed than *T*'s. Samples of writing from 7 to 14 years are given in Figure 9.

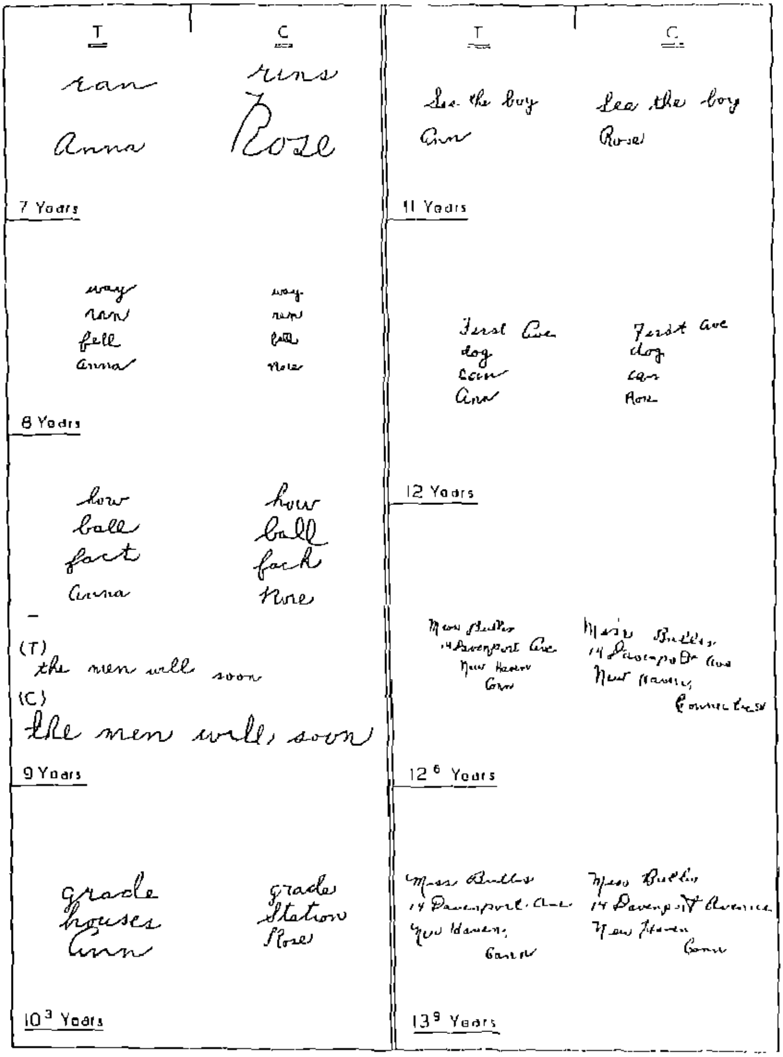

FIGURE 9

HANDWRITING SAMPLES OF TWINS *T* AND *C* FROM 7 YEARS TO 13 YEARS, 9 MONTHS

3. *Configurational Differences in Tap-Dancing*

For several years the twins have practiced duet tap-dancing with success and enjoyment. Needless to say they have attained a high degree of unison in their team work. Their dancing at 10 years and 3 months, and again at 12½ years was filmed. This has given us another objective basis for comparing their motor behavior.

Twin *T* moves more vigorously when tap-dancing and completes

TABLE 8

Episode 1[2]
T bends knees more and lifts hands higher in clapping (farther apart).
**T* lifts right foot farther out to side than *C* does.
**T* lifts outer hand way to shoulder; *C* lifts hers not even to waistline.
C lifts inner hand higher.
**T* swings outer hand farther behind her.
**T*'s hands meet well behind her neck; *C*'s come only to shoulder.
**T*'s feet wider apart.
C lifts foot higher.
**T* lifts arms higher and wider, though *C*'s foot is higher.
Episodes 2 and 3
**T* lifts hands higher and farther apart before clapping.
**T* does spread legs farther apart.
*Same again.
**T*'s arm goes farther down in down-sweep.
**T*'s hands well up to neck; *C*'s just limply at shoulders.
C's hands farther apart before the clap.
C's foot goes up farther.
**T*'s feet farther apart.
**T*'s arms up higher and farther apart though *C*'s foot goes up higher.
**T*'s outer arm describes a wider arc.
**T*'s hands come well up to neck; *C*'s just to shoulders.
**T*'s left hand lifted higher than *C*'s.
Episodes 4 and 5 (Closeup of foot behavior)
**T*'s feet go farther apart.
C's foot goes back a little farther.
**T*'s foot goes back farther.
**T*'s foot goes back farther.
C's feet farther apart.
**T*'s feet farther apart.
**T*'s feet farther apart.
**T*'s feet much farther apart.
**T*'s feet farther apart.
C's a little farther apart.
Episode 6 (Full length)
**T* lifts hands higher for clap.
**T*'s feet wider apart.
C extends arm farther to side as they kneel.
**T* extends arm a little farther to side and holds.

---

[2] *Indicates more complete movement for Twin *T*.

her movements more perfectly. *C* comparatively was relatively more lackadaisical and indecisive. On the basis of this criterion, of the 35 times (at 10 years and 3 months) when there is an ascertainable difference in the completeness of movement, *T* executes the movement more fully 27 times (or 77 per cent), irrespective of any temporal differences.

A descriptive analysis of these differences appears in Table 8.

4. *Laterality.*

Laterality may be regarded as a significant aspect of demeanor. Laterality is a useful kind of functional asymmetry. Voluntary behavior requires an asymmetric focalization of motor set, which expresses itself in handedness, eyedness, and footedness.

a. Handedness. It was possible to study the development of handedness comparatively and to some extent quantitatively, with the

TABLE 9

SUMMARY OF HANDEDNESS AS OBSERVED IN THE CINEMA

Age	*T*	*C*
28 weeks	Right or both	Left
38 weeks	*Right or both*	*Left*
42 weeks	Right most; some bilateral	Right or left
52 weeks	Right or left	Right or left
15 months	Right or left. Left most	Right or left
18 months	*Left most; right some*	*Right most; left some*
21 months	Right most	Right most
2 years	Right	Right
2½ years	Right most. A little left	Right most. Some left
2 yrs. 9 mos.	Right most. Much left	Right most. Considerable left
3 years	Right and left	Right and left
4 years	Right most	Right and left
4½ years	Right and left	Right most. Some left
6 years	Right most. Some left	Right and left
6½ years	Right most	Right
7 years	Right	Right and left
7½ years	Right	Right and left
8 years	Right	Right
9 years	Right	Right
10 yrs. 3 mos.	Right	Right
11 years	*Right*	*Right*
12 years	Right	Right
13 years	Right	Right

T was rated as right-handed at 12 age levels, as left-handed at 2 age levels, as bidextrous at 9 age levels.

C was rated as right-handed at 9 age levels, as left-handed at 2 age levels, as bidextrous at 12 age levels.

aid of cinema records made at 23 age levels from 28 weeks to 13 years of age. On the basis of film analysis a judgment was made as to whether the manipulatory behavior of a given twin was predominantly right handed, left handed, or bidextrous. Table 9 summarizes these judgments.

Inspection of the films clearly showed that the degree of unilaterality was more pronounced for *T* than for *C*. When *T* was rated bidextrous, she still used the right hand most and the left hand less, whereas in the case of *C*, both hands were used to about the same extent, or with a slight preponderance of the left hand. On the objective basis of the cinema records, *C* is unquestionably more bidextrous and showed a definite tendency toward left handedness. Under moderate training and social pressure *C* learned to manipulate eating and writing utensils with the right hand, but she still shows a greater readiness than *T* to use the left hand. Examination of the films and of the growth trends reflected in the table revealed that *T*'s unilaterality was well established long before *C*'s.

The variations from age to age suggest that a reciprocal organization process is at work which shifts the unilaterality from time to time, and accounts for the apparent reversal at 18 months of age.

Handedness differences have also been noted in special test situations from age to age. At three years of age the twins were each given a book whose pages turned either way. *T* turned hers from right to left; *C* turned hers from left to right. At four years of age they were given a peg board. *T* held the board in her left hand and pulled out the pegs with her right. *C* reversed the procedure, holding the board in her right hand while she pulled pegs out with her left.

At the age of 8½ years and again at 9 both *T* and *C* threw with the right hand, batted with the right hand, counted with the right hand, and folded paper with the right hand. At 13 years though both used the right hand predominantly, *C* used her left hand to pick up pellets at her left, while *T* used her right hand.

b. Eye dominance. When *T* and *C* were 8½ years old, their eye dominance was tested with the Miles *V*-scope. On all 10 trials *T* invariably used the left eye; *C* the right eye. A check test at nine years confirmed this finding.

Eye dominance was again tested at the age of 13 years, 3 months, this time by looking through a hole in a card. Again *T*'s left eye was dominant and *C*'s right eye was dominant.

It is very likely that this difference in eye dominance, combined with handedness tendencies, is related to their different writing postures. Incidentally it may be recalled that *T*'s auditory acuity is slightly better on the right than on the left. *C*'s auditory sensitivity on the right and left appears to be the same (Figure 6).

c. *Footedness.* A brief study of footedness in the walking board situation was undertaken. Table 10 indicates which foot led off and was first planted on the walking boards by *T* and *C* from 6 to 12 years. Right and left feet are indicated by the letters *R* and *L*. The first letter in each case refers to performance on the 6 cm. board; the second to performance on the 4 cm. board; and the third, to performance on the 2 cm. board.

TABLE 10

FOOT USED FIRST ON WALKING BOARDS

Trials		6 yrs.	6½ yrs.	7 yrs.	7½ yrs.	8 yrs.	9 yrs.	10½ yrs.	11 yrs.	12 yrs.
I	*T*	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR
	C	*RRL*	*RRR*	*LLL*	*RRR*	*RRL*	*RRR*	*RRR*	*RRR*	*RRR*
II	*T*	RLR	RRR	RRR	RRR	RRR	RRR	RRR	RRR	RRR
	C	LRR	RRR	LLL	RRR	RR?	RRR	LLR	RRR	RRR
III	*T*	*RRR*	*RRL*	*RRR*	*RRR*	*RRR*	*RRR*	*RRR*	*LRR*	*RRR*
	C	RRL	RRR	RLL	RRR	RLR	RRR	RRL	RRR	RRR

Though each twin used her right foot predominantly to start with, it will be seen that *T* started 78 times with her right foot, only three times with her left; while *C* started with her left foot 16 times, using it exclusively, with one exception, at seven years. This preferential use of the left foot agrees with her frequent use of the left hand in manipulatory situations in suggesting a relative bilaterality of feet as well as hands.

A record was kept to determine, when a twin lost balance, wheth-

TABLE 11

STEP-OFF ON WALKING BOARDS

Age in years	*T* Right	*T* Left	*T* R-L	*C* Right	*C* Left	*C* R-L
6	6	5	1	9	7	2
6½	6	6	0	7	6	1
7	2	5	—3	4	2	2
7½	4	5	—1	2	0	2
8	6	3	3	2	1	1
9	3	1	2	2	2	0
10½	1	0	1	0	0	0

er she stepped off on the right or left of the board. *T* showed no consistent tendency from age to age in this reaction; but *C* stepped off more frequently at the right of the board (Table 11).

Laterality trends express themselves when the twins assume side by side positions. The spontaneous orientation in dancing brings *C* at *T*'s right. If hands are joined, *C*'s hand supinates to receive *T*'s pronate hand.

B. TIMING AND SPEED OF MOVEMENTS

Much of the behavior of the twins in the developmental examinations was recorded by cinema.[3] In most of the situations both twins were simultaneously tested by two examiners (A.G. and H.T.) who took care to synchronize the presentation of the test materials and to keep the external stimulus factors equal for both twins. Twins are used to each other in a far reaching sense. The mere presence of a familiar co-twin had a profoundly stabilizing influence upon the developmental examinations. The various behavior situations had such a high degree of experimental control that they justified a minute analysis of the cinema records to determine the timing and speed of specific movements.

The method of cinemanalysis, described elsewhere (1) consists essentially of a frame by frame dissection of significant action patterns and behavior episodes. Each frame marks a time lapse of approximately .067 seconds. An inspection of adjacent frames and a consecutive series of frames affords a picture of the course of any given movement. Frame counting and critical inspection accordingly yield time and space values which can be used for minute objective comparison. The following behavior situations were subjected to such time-space analysis: stair climbing, walking boards (on basis of stop watch records), tap dancing, ring-string-and-bell, puzzle-box and ball, cube construction.

1. *Stair Climbing*

The cinema records of stair climbing performance proved to be well adapted for incisive comparisons of motor tempo and speed. An experimental staircase of four treads was placed beside a crib, the platform of which constituted a fifth tread. The staircase and a lure on the platform constituted an adequate stimulus for climbing behavior. The twins were tested both singly and together.

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[3] For further details concerning edited instructional films see *Addendum* on page 121.

The comparative study of this behavior was begun at the age of 46 weeks when both twins were at a nascent stage for climbing. Prior to this time the development of postural behavior was very similar, with slight evidences of relative acceleration in Twin *T*. At 6 and 8 weeks, *T* was more active; at 36 weeks she wavered less in free sitting and showed a trifle more tendency to progress when prone; at 38 weeks she strained forward more in sitting and gave slightly more support when held standing; and at 40, 42, and 44 weeks *T*'s performance in standing was a shade better than *C*'s in self support and balance. At 46 weeks there were no discernible differences. Each pulled herself to standing, stepped forward when both hands were held, and lifted one foot when placed before the staircase; but neither twin was able to place a foot or a knee on the first tread.

At this point in the twins' development, the experimental study reported in 1929 (3) was begun. Twin *T* was given a daily 10-minute practice period in stair climbing. At the end of six weeks, *T* could climb the steps in a little over 25 seconds while *C* did not yet progress further than putting the left knee on the first tread. *T*'s training was discontinued at this time (age 52 weeks) and a week later *C* was given similar training. On the very first day of her training *C* scaled the steps seven times, a performance only approximated by *T* after three weeks of training and not surpassed until five and a half weeks of training. *C*'s added seven weeks of maturity at the time of her training was sufficient to offset *T*'s slightly better postural control plus three weeks of practice. *C*'s training continued for only two weeks.

At the end of this two-weeks training period, *C* (age 55 weeks) scaled the steps in 10.3 seconds; while *T*, age 52 weeks, at the end of six weeks training, took 25.8 seconds, or twice as long. The average time to completely scale each tread was .84 seconds longer for *T*. Nevertheless, one week later, when *T* and *C* were 56 weeks old, their performance on the experimental steps was remarkably alike (Table 12).

This table lists in adjacent columns, 1, the interval from the beginning of ascent to placement of one foot, 2, the interval from contact of one foot to placement contact of the other foot. The interval is expressed in number of cinema frames as counted on the analytic viewer. The time value of a single frame is .063 seconds.

TABLE 12

COMPARATIVE TIME IN TERMS OF CINEMA FRAMES REQUIRED TO CLIMB STAIRCASE (AGE 56 WEEKS)

	T		*C*	
	1	2	1	2
Left foot on tread one	0	0	0	0
Right foot on tread one	23	23	24	24
Left foot on tread two	18	41	23	47
Right foot on tread two	17	58	23	70
Left foot on tread three	19	77	56	126
Right foot on tread three	19	96	26	152
Left foot on tread four	15	111	20	172
Right foot on tread four	17	128	11	183
Left knee on crib (five)	81	209	16	199
Right knee on crib (five)	13	222	24	223
Total time in seconds	13.8		13.9	

1. Number of frames from time one foot in contact with step until other foot makes contact.
2. Frames from beginning of ascent until foot is in contact with tread.

It will be noted that the number of frames recording total ascent to the crib platform was 222 for *T* and 223 for *C*! The total climbing time was *T*: 13.8 seconds; *C*: 13.9 seconds. These absolute values conceal an interesting tempo difference which has been observed in other motor situations: *T* performs more rapidly at the beginning of a performance and slows down perceptibly near the end. *C* slows down earlier.

Stairclimbing performance for the period from one to three years was also studied by cinemanalysis. Records varying in length from 12 to 88 seconds were available, embracing from two to eight ascensions of the entire flight of five treads, each ascension exhibiting the complete four-limb sequence several times. The accompanying table summarizes the comparative findings.

The figures in Table 13 indicate the average number of seconds' duration for a movement of the limb in question. The italicized figures indicate the number of seconds between the lowering of one limb to the step and the lifting of the next following limb. A minus sign denotes that a second limb lifts before a first has come to rest. A plus sign denotes that there is a pause between the lowering of one limb and the lifting of the next limb.

A study of the table reveals striking similarities in the timing of corresponding movements of the two infants, in spite of the fact

TABLE 13

TEMPORAL DESCRIPTION OF STAIR CLIMBING BEHAVIOR IN TWINS *T* AND *C*:
DURATION OF MOVEMENT IN SECONDS

	52 weeks		56 weeks		80 weeks		92 weeks		2 years		3 years	
Limb moving	*T*	*C*	*T*	*C*	*T*	*C*	*T*	*C*	*T*	*C*	*T*	*C*
Left foot	1.06	Only placed left knee on tread. Did not climb.	.93	.93	.75	.87	.68	.56	.62	.56	.62	.62
Pause	+.25		+.12	+.25	+.12	+.37	+.12	+.18	+.12	+.12	—.25	—.06
Left hand	.81		.56	.62	.56	.62	.56	.50	.55	.50	.56	.56
Pause	—.18		—.50	—.25	—.31	—.31	—.18	—.06	—.31	—.31	—.18	—.06
Right foot	1.31		1.25	1.00	.75	1.06	.75	.56	.68	.56	.68	.62
Pause	+.25		+.25	+.12	+.12	+.37	+.18	+.06	+.12	—.06	—.18	—.18
Right hand	.75		.56	.68	.56	.62	.56	.50	.50	.43	.50	.50
Pause	—.18		—.43	—.25	—.12	—.12	—.31	—.12	—.18	—.18	—.18	—.18
Left foot	1.06		.93	.93	.75	.87	.68	.56	.62	.56	.62	.62
Whole pattern	3.62		2.62	2.87	2.31	3.12	2.25	2.00	2.00	1.62	1.81	1.87
Pause between	+.25		+.12	+.25	+.12	+.37	+.12	+.37	+.12	+.12	—.25	—.06
sets of limbs	+.25		+.25	+.12	+.12	+.37	+.12	+.06	+.12	+.06	—.18	—.18

that Twin *T* was trained in climbing from 46 to 52 weeks, and Twin *C* was *not* trained until 53 weeks old and then for only two weeks. *At only one age (80 weeks) does the difference in timing for the four-limb pattern exceed .38 seconds, and at three years not only is the timing for the whole four-limb pattern almost exactly the same (1.81 seconds for Twin T, 1.87 for Twin C) but three of the four limbs take exactly the same time (on the average) for movement in the two children.*

It is interesting to note the fluctuant nature of their relative speeds in stair climbing. At 56 weeks, possibly because of *T*'s earlier training in climbing, *T* is about .25 seconds quicker so far as the whole four-limb pattern is concerned. At 80 weeks this lead has increased to about .80 seconds. However, after this, *C* spurts ahead and at 92 weeks and at two years *C* is quicker, by from .20 to .40 seconds. At three years both speed and timing are practically identical.

The foregoing figures are based on averages. At both 56 weeks and 80 weeks *C*'s timing for individual limb movements is more variable than *T*'s. At 92 weeks, on the contrary, *C* is less variable for three limbs, more variable only in regard to her left foot movements. At two years *C* is less variable for two limbs, equal for right hand behavior, more variable as to her left hand. At three years *C* is less variable for every limb. Table 14 presents these differences in variability and shows that *T*'s individual limb behavior becomes increasingly more variable as to timing while *C*'s becomes increasingly less variable.

TABLE 14

VARIABILITY OF TIMING FOR LIMB MOVEMENTS IN STAIR-CLIMBING: TIME IN FRAMES

Limb	56 weeks *T*	56 weeks *C*	80 weeks *T*	80 weeks *C*	92 weeks *T*	92 weeks *C*	2 years *T*	2 years *C*	3 years *T*	3 years *C*
Left foot	9-18	9-22	9-15	7-23	9-15	7-14	7-18	8-14	6-19	8-14
Left hand	8- 9	7-14	9-10	8-14	7-11	7- 8	6-11	6-12	6-12	6-12
Right foot	17-25	10-23	11-13	9-22	10-15	8-10	8-20	6-15	5-16	6-15
Right hand	6-13	6-17	8-11	7-13	6-11	7- 9	6- 9	5- 8	4-14	5- 8

2. *Locomotion*

A slight advance in postural development on the part of *T* has already been noted. *T* walked alone about two weeks earlier than *C*; she has also been slightly advanced in physical maturity.

When the twins were 3½ years old they were given a battery of motor tests, among them Cunningham's tests of stepping on blocks, and stepping into 8-inch rope hoops with alternating feet. These tests were repeated a week later to check for consistency. On each occasion *T* was more skillful than *C* both in stepping and in maintaining balance.

At 4½ years of age the twins were given a special course of training on walking boards, over a period of six months. Three walking boards, raised 10 cm. from the floor were used: 6, 4, and 2 cm. in width, 250 cm. in length. The following comparative table gives average time values and errors for performance prior to training (4½ years) and six months after the training period (5½ years).

TABLE 15

PERFORMANCE ON WALKING BOARDS BEFORE AND AFTER TRAINING

		Before training (4½ years)			After training (5½ years)		
	Board width	*6 cms.*	*4 cms.*	*2 cms.*	*6 cms.*	*4 cms.*	*2 cms.*
Time in Seconds	*T*	13.2	20.0	28.5	7.9	11.0	13.8
	C	17.6	20.2	27.8	9.3	10.5	11.2
Errors	*T*	.8	4.0	7.5	0	1.2	3.7
	C	2.3	4.0	7.8	.15	.8	4.4

At both 4½ and 5½ years *T* walked the 6 cm. board more rapidly and stepped off fewer times than *C*. On the 2 cm. board *C* was more rapid than *T* but she stepped off more than *T*.

The twins' performance on the 6, 4, and 2 cm. walking boards was subsequently tested at nine ages from 6 to 12 years. Each twin had three trials on each board—first the 6 cm. board, then the 4 cm. board and lastly the 2 cm. board. Record was made of the foot used in taking the first step, the number of step-offs, and the time when *the first foot touched the board until both feet touched the end* platform.

The scores show that both on the 6 and the 4 cm. board *T* is quicker than *C* and keeps her balance better. On the 2 cm. board it is *C* who tends to a better performance. At 7½ years *C*'s superior balance was obvious and so noted on the record. She steps off less frequently and makes better time. This apparent contradiction is understandable when the nature of the walking board situation is considered. It is like riding a bicycle. Up to a certain level of difficulty of balancing, speed makes balance easier; beyond that level speed becomes a hindrance. Under certain conditions *C* maintains a more favorable ratio between balance and speed. At the age of 11 years she rode the bicycle better than *T* although both had similar amounts of practice.

At the present age (13 years) in natural walking stride, *T* tends to take the lead, and *C* is likely to be at *T*'s right. *T*'s muscle set is somewhat more tense and she pulls in her chin slightly, but her posture is more erect. *C*'s posture is in comparison more sinuous, more easy and dynamically more graceful. In the 50-yard dash, *T* is quicker on the trigger. Indeed she won first place in a recent track meet, while *C* failed to make the team! In stair climbing we believe they are still evenly matched.

Tap-dancing. Each salient and measurable phase or component in the dancing sequence, such as "hands-clap-together," "hands-come-together-behind-neck," "toe-taps-on-floor," etc., was examined to determine to what extent the twins' behavior coincided or diverged.

Analysis revealed that in 45 out of 88 such measurable items of behavior (10^{3} years), timing for the two girls was exactly the same (that is, within 1/32 of a second). In 43 instances of discrepancy, *T* was the quicker 30 times; *C*, 13 times. *T* completed her movements more decisively. Her tonicity was better. She seemed surer of the steps and definitely took the lead. *C* looked to her to see what was to be done. A brief table presents the temporal differences (Table 16).

TABLE 16

TAP-DANCING BEHAVIOR AT 10 YEARS, 3 MONTHS

Of 44 measurable points in relation to *Arm Behavior*
In 23 instances timing is just the same for the two girls.
17 times *T* is quicker (by 1 to 17/32 of a second).
4 times *C* is quicker (by 2 to 6/32 of a second).

Of 44 measurable points in relation to *Leg Behavior*
In 22 instances timing is just the same for the two girls.
13 times *T* is quicker (by 1 to 4/32 of a second).
9 times *C* is quicker (by 1 to 4/32 of a second).

Foot behavior was analyzed at the age of 12½ years. Of measurable behavior items, such as "taps-toe-on-the-floor," "extends-leg-forward," etc., 80 per cent showed exactly the same timing, as opposed to 50 per cent at 10 years. Eight differences only were found: five in favor of *C*, three in favor of *T*. The largest differences are 4/32 of a second, as at 10 years.

3. *Fine Motor Coördination*

The cinema records of motor tests in the developmental examination provide quantitative data for comparing speed and timing in manipulatory activities. The tables below give the absolute cumulative values in seconds for sequential manoeuvers in four test situations, namely ring-string-bell, ball and box, cube construction, and pellets into the bottle.

These situations required a moderate degree of insight and chiefly *tested powers of fine motor coördination, including prehension,* release, and accuracy of directional control.

(*a*) A string (8 in. long) attached to a 4 in. wooden ring, had to be plucked and pulled to drag in a coveted hand bell placed within the circumference of the ring. (*b*) The cover of a puzzle box containing a half visible ball had to be secured by removing a small wooden rod from a loop of binding string. (*c*) A bridge, a gate, or a tower had to be built with one-inch wooden cubes. (*d*) Ten pellets were thrice presented, five on either side of a one ounce glass bottle, *and each time the twins were asked to put them into the bottle.*

Tables 17-20 list the component manoeuvres for each situation in progressive sequence. In cube construction and pellet placement, *T* completes her task slightly in advance of *C*, but the timing is extremely similar. In the ring-string and ball-box episodes, the similarity reaches almost complete identity.

TABLE 17

RING-STRING-AND-BELL BEHAVIOR (18 MONTHS)

	Time in frames	
	T	*C*
Starts to reach	0	0
Touches string, left hand	13	13
Looks up at Ex.	11 & 42	28
Starts pulling in	27	29
Looks back at ring and string	56	56
Starts pulling again	56	56
T pulls ring off table, *C* doesn't		
Picks up bell	130	141

TABLE 18

BALL AND BOX BEHAVIOR (2 YEARS, 9 MONTHS)

	Time in frames	
	T	*C*
Presented	0	0
Both hands on it	3	3
Hand on top	18	18
Turns box onto its side	56	80
Rod out of string	93	117
Cover off box	*179*	*172*
Lifts out ball	207	204
Drops ball on table top	225	245

TABLE 19

CUBE CONSTRUCTION (18 MONTHS TO 13 YEARS, 4 MONTHS)

		Time in frames	
Age	Situation	*T*	*C*
18 months	Tower of 2, then 3	24, 71	128, 148
4 years*	Bridge building	144	208
4½ years	Gate building	128	160
6 years	Tower of 4	96	176
7 years	Tower of 10	208	256
8 years	Tower of 10	272	384
9 years	Tower of 10	272	304
11 years	Tower of 10	368	368
12 years	Tower of 10	304	288
13^4 years	Tower of 10	224	160

*Ages 2, 3, 5 years are omitted because cinema records for the two children are not comparable in terms of external control.

TABLE 20

PELLETS INTO BOTTLE (13 YEARS, 4 MONTHS)

	Time in frames	
	T	*C*
Presented	0	0
Starts to lift arm	21	23
Touches pellet	31	31
Lifts pellet	37	42
Pellet in bottle	42	49
Starts on left-hand pellets	74	92
Last pellet in	111	134
Hands in lap	123	143
Pellets re-presented	0	0
All in	146	181
Pellets re-presented	0	0
All in	144	169

IV. ADAPTIVE BEHAVIOR

A. Rate of Development

The comparative rate of mental growth in Twins *T* and *C* is reflected in the maturity ratings which were made on the basis of age norms. In infancy an allowance of two weeks was made for prematurity. Twenty-two developmental examinations and intelligence tests were made between the ages of 24 weeks and 13 years. The results are summarized in the table which follows (Table 21). A descriptive developmental quotient based on the adaptive behavior ratings of the Yale schedules was assigned after each of the 14 examinations prior to six years. After this age a psychometric quotient was derived on the basis of the Stanford-Binet (1916 Revision).

TABLE 21

Age of child	Twin *T*	Twin *C*
	Approximate *DQ*	
24 weeks	75	75
28 weeks	75	75
32 weeks	75	75
36 weeks	75	75
40 weeks	80	80
44 weeks	75	75
48 weeks	80	80
52 weeks	80	80
62 weeks	80	80
80 weeks	80	80
2 years	85	85
3 years	90	85
4 years	90	90
5 years	95	95
	IQ	
6 years	103	100
7 years	100	97
8 years	104	97
9 years	101	97
10 years	87	88
11 years	92	92
12 years	90	90
13 years	89	85

There is a rather wide range of variations from *DQ* 80 at one year to a maximum of *IQ* 104 at eight years, with a recession to 85-90 at 13 years. The quotient range 85-90 is fairly descriptive of the intellectual level of the twins. The fluctuations in the quotients were closely parallel at all ages. The divergence never exceeded seven quotient points. *On 16 examinations the quotient ratings were identical.*

The significance of the fluctuations will be briefly considered in a later section. Here we may emphasize the fact that these fluctuations occurred contemporaneously. They were staggered only to a very slight degree, and even the individual test items showed a high degree of correspondence. This means that the specific abilities which determined "the general maturity level" were remarkably alike. Records of the developmental examinations for the first 80 weeks were analyzed by one person (A.G.). In all, 612 separate comparative ratings were made. Of these, 513 indicated identical correspondence, 82 indicated a plus divergence, and 17 a minus divergence using Twin *C* as the standard of comparison. It should be stated that the divergences were slight in degree though consistent in trend.

A striking illustration of the thoroughgoing correspondence in behavior patterning is afforded in the progressions of pellet prehension. A small white pellet, 8 mm. in diameter, was placed on a table-top before each child, within easy reach. At 28 weeks both the twins, being somewhat retarded in their perceptive development, were visually unheedful of the pellet, though they definitely regarded a cube. At 38 weeks they addressed themselves in an identical manner to the pellet. They placed their hands on the table, in full pronation, the fingers fully extended and the thumb abducted almost at right angles. *The photographic record of their attack upon the pellet in the motion* pictures shows an almost uncanny degree of identity in the details of postural attitude, hand attitude, approach, and mechanism of prehension. At 40 weeks there was a crude raking attack upon the pellet; at 42 weeks this raking approach was replaced by a poking with the tip of the index finger. These changes in prehensory pattern occurred contemporaneously in both children. Such correspondence in behavior pattern, therefore, denotes not only a high degree of resemblance in immediate performance but also a high degree of synchronousness in the tempo of ontogenesis.

Remarkable correspondences have been found not only in motor performance but in the fields of verbal behavior. Language development will have separate consideration. *C* has been more fluently expressive both in speech and action, but *T* is slightly more able than *C* in defining abstract words. If there is a genuine difference in intellectual ability it is very slightly in favor of *T*.

A few situations which reveal the operations of adaptive behavior will now be considered, special attention being given to the objective evidences of drawing.

B. Digit Repetition

When the twins were first given the digit repetition test at 4½ years of age, *C*'s performance was slightly better than *T*'s. This difference was likewise noted by Hilgard who then alternately trained Twin *C* and Twin *T* in digit repetition for a period of eight weeks each. When the twins were retested three weeks and six weeks after completion of the training, the relative ability of *T* and *C* was found to be unchanged. In nine subsequent tests given from 5 to 12 years, *C* gave a better performance on all but three occasions when the performance was identical.

In repeating digits backward, a different result was obtained. This test was given at yearly intervals from 7 to 12 years. On four occasions *T* gave a superior performance; on one occasion, *C*. At seven years performance was identical.

C. Fluency of Association

The word naming test at the 10-year level on the Stanford-Binet gives a measure of fluency of association. This test was presented to *T* and *C* annually beginning at the age of seven years. The full 3 minutes for response was allowed and the actual responses for each half-minute recorded. The number of words given at each age is shown in Table 22.

TABLE 22

Number of Words Given in Three Minutes

Age in years	*7*	*8*	*9*	*10*[3]	*11*	*12*	*13*
By *T*	32	25	55	59	56	46	40
By *C*	24	49	49	59	50	58	47

It will be seen that both children tend to poverty of association and that neither child is consistently more fluent than the other. At every age both gradually diminish in fluency after the first half-minute.

D. Constructiveness

Imaginativeness and planfulness were exposed by a formal free construction test. Each twin was asked independently to make something out of 59 pieces of construction material, consisting of small

TABLE 23

FREE CONSTRUCTION

Age in years	*T*	*C*
8	Apparently more planned, detailed and elaborate. Uses all materials. Time 7′ 35″ "A building." "Table and chair." "Design." "Building." "Another building." "Shop." "Stairs." "Barrel."	Makes simple structure, then sits and looks at it. Time 3′ 40″ "Looks like a design." "T." "Stairs." "Design."
9	Elaborate detailed construction. Time 17′ 13″ "Village." "There a fence and between here's flowers. Dose dere like fence. In here is flowers growing too. Garages to put their cars in. Chimney."	Two upright towers and a few pieces between them. Time 0′ 50″ "A fence with the house in back. Grass."
10[3]	Uses a few upright blocks in a fairly open structure. Time 3′ 23″ "A gasoline station."	Complex structure using small pieces. Rearranges frequently. Time 6′ 7″ No reply as to what had been built.
11	An arrangement of uprights in 3 groups topped with rods and color pieces. Pieces fall occasionally. Time 4′ 15″ "A gasoline station."	A consolidated group of uprights topped with color pieces and rods. Time 3′ 12″ "A gasoline station."
12	Two groups of uprights each with color pieces on top and flat rods between. Time 3′ 20″ "A big building here and a small building here and a bridge between."	Two groups of uprights each with color pieces on top and flat rods between. Time 2′ 5″ "A fence with a driveway."
13	*(With cubes only)* Three dimensional structure. Time 31,5″	*(With cubes only)* Simple two dimensional structure. Time 13″

wooden blocks with holes into which wire and wood could be fitted, and an assortment of wooden plaques of different shapes, sizes, and colors. The resultant constructions and comments at five annual intervals are listed in Table 23.

At only one age does *C* spend more time than *T* at the task. *T* usually built more elaborately and worked with greater intentness and drive. *C* finished more quickly, named what she had built less readily, and made a simpler structure. This behavior may be compared with *T*'s and *C*'s behavior in the free play situation, to be discussed in a following section. The construction test differs from the free play situation in the fact that a formal task is proposed.

E. Block Building

The red one-inch cubes which were used in the examination of

TABLE 24

SIMILARITIES IN END PRODUCTS OF CUBE BEHAVIOR (28 WEEKS TO 10 YEARS)

28 weeks

Cube regarded for several seconds, but no reaching.

36 weeks

Both pick, bang, brush and transfer cube.

38 weeks

Each grasps a first cube, approaches a second, fails to grasp two at once, pushes one from table top with the other. Both regard Examiner and paper screen, and reach simultaneously for screen with left hands. Look over left shoulders. Reach simultaneously with right hands, left hands in abeyance. *T* transfers, *C* doesn't.

42 weeks

Both pursue a second cube with a prehended first cube and finger the edges of another cube. Both transfer. Both hold two cubes and contact a third. Both bang cube on table top.

44 weeks

Both exploit cubes in same way, banging and bringing cube to bear against the side rail of crib. *T* transfers and combines oftener. Both exploit multiple and fallen cubes to same degree.

46 weeks

Both retain firm hold of two cubes. Both approach third cube with one cube in hand. No combining.

48 weeks

T holds cube, *C* bangs cube. Both brush cubes. Neither builds tower.

52 weeks

Pick up first cube, transfer, pick up second, drop left-hand cube and pick up third, holding two. Heed but one cube at a time. No definite combining activity. Considerable lateral brushing.

63 weeks

Tend to build tower; restore blocks from platform to table top; one by one seizure of multiple cubes.

TABLE 24 (*continued*)

79 weeks

Both spontaneously build tower of three; exploit single cubes by playfully casting to table top. Build tower of two in multiple cube situation.

93 weeks

Massed cubes: Each takes top cube off first, with right hand, then casts others, one at a time, over side rail.

2 years

Little similarity in response. *T*'s maximum achievement is a tower of three; *C*'s a tower of two. Neither builds train.

2½ years

Massed cubes: Both stand up to look over screen at cubes. Both take off top block then pick up others one at a time.
Tower: Both build tower of ten, though *T* on first trial, *C* on fourth.
Train: Each builds train of ten, without chimney, and pushes.
Bridge: Both make train of three and take Ex's cube for fourth.

3 years

Train: Both make train with chimney and push, though *C* fills up the square of four.
Bridge: Both succeed though *T*'s bottom cubes aren't well separated.
Gate: Both make good attempts but fail.

3½ years

Spontaneous: Both start simultaneously to place the cubes in a neat row on the table, arranging them until all cubes are in line.
Train: Build train, add chimney, push train saying "Choo choo."
Bridge: Both build successfully.
Gate: *T* builds correctly, *C* only partly correct.

4 years

Massed cubes: Both take off top cube and scatter cubes. Neither builds a tower. *C* nearly rebuilds original massed cube structure.
Bridge: Both succeed though *C*'s top cube is at a slight angle.
Gate: Both fail first attempt, succeed on second.
Steps: Both fail, building a tower double part of the way.

4½ years

Massed cubes: Each builds a tower, *T* a single, *C* a double one.
Bridge: Both succeed.
Gate: Both succeed though *C*'s middle cube is placed too high.
Steps: Both fail, *T* making a horizontal, *C* a vertical structure.

5 years

Massed cubes: Both build bridges with center cubes tipped, and call them houses.
Bridge: Both imitate successfully.
Gate: Both succeed.
Steps: Both fail.

6 years

Massed cubes: Both build a tower of ten.
Steps: Both fail, though *T* comes nearer to success.

7 years to 8 years

Tower building: Both take cubes from the right hand end of cubes in a row, using their right hands.

9 years to 10 years

Tower building: Both take cubes from left hand end of cubes in a row, using their right hands.

the twins' behavior in early infancy have proved useful for purposes of comparative observation throughout our study. The following synopsis reveals a high degree of similarity not only in the end products of cube construction, but in the methods of construction. The comparisons from 28 weeks to 80 weeks are taken largely from the co-twin control study (3, pp. 81-85). As this study explains, daily training of *T* in cube behavior from 46 to 52 weeks did not result in any conspicuous superiority of *T* over *C*, the untrained twin. Comparisons from 80 weeks to 10 years are made from both written records and cinema (Table 24).

F. ATTENTIONAL DISTRIBUTION

The deftness, directness, and dispersiveness of manipulatory behavior were investigated by means of cinema records and associated stenographic accounts of the behavior. The various cinema situations, particularly the massed cube and tower tests yielded the most fruitful comparisons. The former released spontaneous exploitation; the latter demanded more channelized behavior.

1. *Cube Behavior*

The comparative observations with special reference to cube behavior at various ages are summarized in Tables 25-27. These tables reveal a marked similarity in the end products of the twins' cube behavior, but a consistent difference in regard to manner of manipula-

TABLE 25

CUBE BEHAVIOR OF *T* AND *C* AT 42 WEEKS

Situation	
Twin *T*	Twin *C*
First cube	
Lifts right hand as cube is presented. Grasps cube between thumb and forefinger of right hand and scrubs over table top. A little banging. Finally looks at Ex. Has transferred cube to left hand. Bangs it on table top.	Reaches for the cube with left hand as it is presented. Picks up in whole-hand grasp, looking at Ex. Keeps looking at Ex. Finally looks at cube and transfers it to right hand and bangs on table top. Then cube to mouth in both hands.
Grasp superior. Little regard for Ex. Banging and transfer same as C. Right hand initial approach.	*Grasp inferior. Mostly regards Ex. Banging and transfer same as T. Cube to mouth. Left hand initial approach.*

TABLE 25 (*continued*)

Situation	
Twin *T*	Twin *C*
Second cube	
Contacts second cube with first and pushes it along table to right and then left and off table top. Looks at cube on platform. Bangs it with cube in hand.	Takes cube in right hand (first in left). Bangs it on table top. Looks at Ex. for a long time, turning to left. Finally bangs left hand cube twice on platform.
Does not pick up second cube but manipulates it almost continually with first.	*Picks up second cube and bangs it on table top. Does not combine cubes. Mostly looks at Examiner.*
Third cube	
Regards third, holding a cube in each hand. Contacts third vigorously with left-hand cube then with right. Rotates left wrist, holding cube.	Regards third, a cube in each hand, right-hand cube at mouth. Contacts third with left-hand cube, one brief contact at side, then holds out left-hand cube to Ex. Keeps looking at Ex. Turns front and bangs once at third cube with rt.-hand cube, knocking it out of reach. Approaches it with both hands but no contact. Approaches it with right-hand cube but no contact. Swings right foot into step position.
Continuous attention for cubes. Contacts third vigorously with second, and first.	*Cube to mouth. Most attention for Ex. More body activity, moving around. Does contact third cube once with other cube.*
Massed cubes	
Regards withdrawn paper shield, then pushes cubes apart with right hand. Does this for some time. Picks up one and pushes others with it. Drops. Then same with another. Same with cube in left hand.	Regards withdrawn paper shield, and then regards Ex. turning and looking over her left shoulder. Looks way to right. Finally regards cubes and picks up one in right hand then one in left. Pushes at cubes twice with left-hand cube. Left-hand cube to forehead and eye; right to near mouth. Bangs right on table top, then brings both together near chest, and left to mouth.
All attention for cubes. Combines, pushing.	*Some cube combination. Most attention for Ex. Brings cubes to face.*
Total time: 36 seconds	*Total time*: 37 seconds

TABLE 26

CUBE BEHAVIOR OF *T* AND *C* AT 2 YEARS 9 MONTHS

T	*Time in seconds*		*C*
Cubes presented	0.00	0.00	Cubes presented
Puts hands around them.	.68	1.00	Puts hands around them
Pulls cubes toward self	2.56	4.12	Takes off top cube, right hand
Starts to build tower, using right hand	5.50	4.94	*Puts cube on table top*
Builds continuously until she has a tower of nine cubes	36.62	6.87	Rubs both hands over table top
Tower falls	37.50	8.56	Puts cube back on pile
Starts to rebuild	38.00	10.87	Arranges pile with left hand
Film cut		12.42	Scatters cubes with right hand
		13.94	Scoops cubes up and drops them
		14.68	Same again
		17.42	Brushes one off table top, left hand
		19.50	*Brushes another off*
		20.87	Two more off
		23.42	All the rest off, wide sweeps of arm
			Film cut

TABLE 27

SUMMARY OF CUBE AND ALLIED BEHAVIORS IN THE DEVELOPMENTAL EXAMINATIONS FROM 28 WEEKS TO 8 YEARS BRINGING OUT SOME DIFFERENCES BETWEEN TWINS *T* AND *C*

(Based on Cinema)

28 weeks

T closes in on the dangling ring right away, C not at all. T regards the rattle: *C* merely regards *T*'s face.

32 weeks

T reaches for cube, grasps it. Takes another in left hand and taps it on table top. Combines cubes. *C* sweeps one cube into her lap with her right hand. Sits and looks. Later grasps a cube in her left hand and sweeps it back and forth.

38 weeks

T transfers dangling ring; *C* does not.
T transfers a cube; *C* does not.
T picks up pellet in a scissors grasp in her right hand, palmar grasp with her left. *C* has a palmar grasp with both hands.
T's finger response is much more deft.

42 weeks

Bell: *T*'s finger response is more deft than *C*'s: she closes down on the bell handle with a precise finger grasp; *C*'s hand comes up from the bowl to grasp the handle.

TABLE 27 (*continued*)

Spoon. Again *T*'s manual response is more advanced.

Cup. *T* shows marked superiority of manipulation by picking up the cup by the handle in pincer grasp. *C* pushes the cup around by its bottom, upside down.

15 months

T piles cube on cube, massed cubes. *C* does too, but her top cube falls off. *T* picks up the pellet more quickly and more deftly than does *C*. *T* manipulates her cubes mostly on table top; *C* scatters hers onto the platform.

18 months

T's response to the ring, string and bell situation is much more complex than *C*'s. *T* pulls ring, string and bell off table, then puts ring on table and bell inside it, pulls it off again, waves the ring, etc. *C* just waves the bell and looks at Ex.

Cubes. *T* builds a tower of 3 cubes while *C* gets a tower of 2 built. *C*'s tower of 3 falls. As at 15 months, *T* manipulates her cubes on the table top, *C* moves hers to the platform.

2 years

T builds a tower of 3; *C*, a tower of 2.

2½ years

T carefully places 10 cubes in a tower. *C*'s careless placement results in her tower falling at 3. *C* makes four trials before building a tower of 10.

2 years, 9 months

Formboard. Both put in all 3 forms, *T* in 10 seconds, *C* in 15 seconds.

Massed cubes. *T* makes a careful tower of all, keeping them all on the table top. *C* scatters hers all off table top with a wide arm gesture. Later, her attempted towers fall at third and fourth cube.

3 years

Gate. *T* makes false starts but does turn cube cornerwise. *C* also fails. Does not seem to get idea of tilting one of the cubes.

Train with chimney. *T* succeeds, and pushes her train. *C* makes a filled-in square of four and pushes it.

4 years

Bridge. *T* makes a good bridge in 9 seconds. *C* takes 12 seconds and her top cube appears to be at an angle.

Gate. *T*'s first attempt is slightly better than *C*'s. On second attempt, *C* is quicker.

7 years

T's tower of 10 is built more quickly than *C*'s.

7½ years

T's tower of 10 is built more quickly than *C*'s.

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tion and attentional distribution. *T*'s manner of manipulation tends to be superior to that of *C*, and her attention is more directed to a given stimulus object and less dispersive.

2. *Play Behavior*

Play behavior is an excellent medium for revealing modes of attentional distribution and associated personality characteristics.

Twins *T* and *C* have always been remarkably similar with respect to their patterns of play activity. In fact, observed separately, it would be difficult to identify distinctive characteristics. But when the records are comparatively studied, and when the twins are observed simultaneously, certain slight differences are found which persist from age to age and which may be traced back to infancy.

To list the differences overemphasizes them. The reader needs constant reminder of the high degree of similarity of the twins. It is precisely because of the high degree of similarity that the differences are revealed with clarity; the same differences in dissimilar children would be considered similarities. With this caution in mind, the differences in play behavior will be listed in order to orient the reader in comparing the examples of play behavior.

The play behavior has been observed both separately and comparatively at advancing ages. Brief examples of characteristic behavior are presented below. The descriptive details in themselves are of no interest, but they acquire some significance if they are regarded as possible indications of characteristic modes of attentional distribution and exploitiveness. Four differences in exploitive play were distinguishable, as follows: (*a*) *T* responds overtly more immediately than *C*; (*b*) *T* responds more discretely to one aspect of the situation; while *C* responds, more than *T*, to the total situation; (*c*) *T* exploits the single situation more diversely while *C* tends to marginal diversion which leads to more limited and repetitive exploitation; (*d*) *T* shifts a given activity more completely, more decisively, and earlier than *C*. *C* shifts her activity less completely by retaining some aspect of previous activity as she shifts to a new activity.

Recalling the caution that the mere formulation of these differences tends to exaggerate their magnitude, the reader may compare the exploitive behavior of the twins in the play situations summarized herewith.

Age 42 weeks. Multiple objects (saucer, paper, string, spoon, cube, rod) placed on table top of examining crib.

Both children gave attention first to the saucer. *C* then lifted the saucer and then the rod. She banged the rod against the cube and then against the saucer. *C* ignored spoon, string, and paper. *T*, in a shorter period of time, first picked up the rod, released it; picked up the paper, waved it; picked up the rod, released it; then transferred the paper from hand to hand three times and brushed it against the saucer. *T* ignored cube, string, and spoon. *T*'s activity shifted from her original regard for the saucer, to the rod, and to the paper; while *C*'s activity centered about the saucer. *T*'s actual activity was more varied than *C*'s, although both twins ignored three of the six objects. At the same age, when *T* and *C* were given the ten cubes, *T* prehended one cube after the other while *C* tended to grasp and regrasp the same cube.

Age 44 weeks. Multiple objects.

Both *T* and *C* gave major attention to the paper: *T* reached underneath for the paper while *C* first briefly manipulated the rod and spoon which lay on the paper. After *C* secured the paper, she manipulated it almost exclusively, only momentarily diverting her attention to the cube. *T*, on the other hand, diverted her attention more completely to the rod, hitting it against the paper, dropping it, regrasping it, and transferring it. When this situation was re-presented, *C* immediately removed the small objects on the paper and manipulated it; while *T* did likewise, but also grasped the spoon and hit it against the paper.

When presented with ten cubes, *T* was more active in manipulation, combined the cubes more and scattered them more widely; at the end of the situation *T* had only 4 cubes left on the table while 6 of *C*'s remained there.

Age 48 weeks. Multiple objects. (In the interval T had had two weeks of directed cube play.)

T again played more discretely with individual objects, exploited them more diversely, shifted her activity sooner, and more completely than *C*. Although both twins attended to first one object and then another, *C* showed a little more continuity in her play. When given the ten cubes, both *T* and *C* at first tended to pick up one cube after another, then *T* put one cube upon another, transferred cubes to platform, patted the crib rail, banged with a cube at the crib rail, and offered the cubes to the examiner; while *C* held a cube above the table and dropped it, pushed a cube with her index finger, and then grasped the cube, brushing it from side to side and off the table. In spite of two weeks of daily cube play, *T* changed more abruptly than *C* from one type of manipulation to another and exploited the situation more diversely, as she did before the training.

Age 52 weeks. Cup and Spoon.

After *T* had had six weeks of directed cube play, she nevertheless displayed her former play characteristics. *C* directed her attention almost exclusively to hitting the spoon on the cup. In doing so she hit the cup out of reach, reached for it, and was persistent in her attempts to secure it. In an equal time period, *T* grasped cup and spoon, offered them to the examiner, banged the cup on the table, rubbed the spoon over the table, and hit the spoon on the cup.

Age 20 months. Spontaneous play in the guidance nursery.

The twins were observed individually for periods of ten minutes in a nursery equipped with a box of building blocks, dolls, small stools, table with cubes and building blocks, blackboard and chalk, and play pool.

T made many more wanderings about the room, making about twice as many excursions from one locus to another. She was much more locomotor than *C*. She transported the stools, the doll chairs and the basket of chalk while *C* transported one fairly large building block, the chalk and the basket. *T* sat for a brief period only, as though to rest and look about. *C*, on the other hand, sat most of the time while playing. *T* piled doll chairs; *C* piled small blocks.

T played with one thing, then left it and apparently turned her attention completely from it. *C* tended to retain what she was playing with and thus made less abrupt transitions. In drawing up an analysis of their play behavior it was easy to make clearcut demarcations for *T*'s play activities but not so for *C*'s. *T* engaged in a greater variety of exploratory activity. *C*'s activity was more repetitive.

Age 3 years. Spontaneous play together, for 25 minutes, in playroom equipped with dolls, doll clothes, dishes and carriage, blocks, paper and crayons, books.

Behavior	*T*	*C*
Number of activities	39	31
Number of objects contacted	19	12
Number of words spoken	218	215
References to observer	8	4
References to co-twin	16	22
Questions about new objects	4	1

These figures reveal a striking degree of similarity. A few differences, however, were discernible. *T* was more alert to her environment and exploited it more completely. Her play was less integrated than that of *C* as shown by the fact that *T* tended to drop what she was doing and give her attention

> more completely to her new interest while *C* integrated her original interest with the new. *C* kept the doll continuously with her while *T* discarded the doll for the cart.

The foregoing differences though slight appeared to be fundamental. We wondered to what extent they could be modified by differential training. Accordingly, from the time when the twins were 3 years 7 months old, until they were 3 years 11 months old, they were brought to the clinic twice a week for differential play experience. In separate rooms, each with an adult, *T* was encouraged to occupy herself with sedentary, manual activity and to continue her play with whatever toy she selected, rather than, as was her custom, to be grossly active and to go from one play activity to another. *C*, on the other hand, was allowed to do as she wished. She was given very limited encouragement and she could run about at pleasure. The details of the study will be reported elsewhere. Here it suffices to say that although *T*'s play patterns were modified as shown by scores on the Cushing Perseveration tests and by activity charts, actually, when the data were closely analyzed, *T*'s and *C*'s fundamental play traits compared as before. Within a narrowed range, physical and mental, *T* still engaged in more discrete, diversified play with more shifts of play activity.

Beginning at 3½ years of age, timed records were made of *T*'s and *C*'s behavior in a playroom equipped with a variety of toys. Figure 10 charts these records. The records just after the play training ending at the age of 4 years have not been included. Except for this brief period after training, there are only two ages (6 and 7 years) when *T* did not divert from her initial play sooner than *C*.

Except at 9 years, *C* spent longer than *T* in doll play. *T*'s play was likely to be more active than *C*'s play, up to 10 years when *T* developed an interest in books. *T*'s play, even with the blocks, was likely to be more discrete than *C*'s.

T was the first to break away from doll play and to build with the blocks (6 years), while *C* was attracted by the paper and crayon. *T*, at 8 years, spent some time looking at the book while *C* was not attracted to it until 10 years. Although *T* diverted from doll play sooner than *C*, *T* continued doll-wagon play longer than *C*.

G. DRAWING

Drawing writes its own record. It is in its way a self-recording

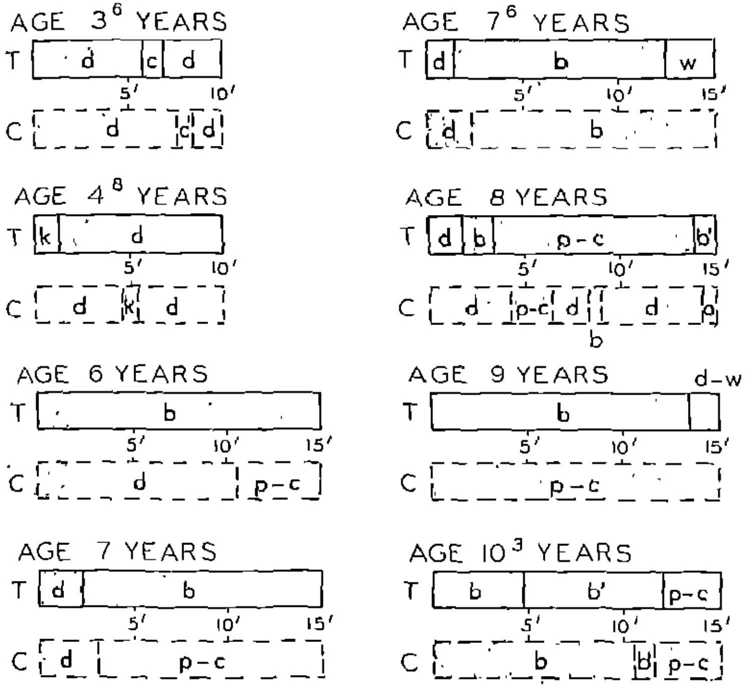

FIGURE 10

SEQUENCE AND DURATION OF PLAY WITH VARIOUS TOYS

(Time expressed in minutes.)

Key: *b* =blocks.
b′=book.
c =carriage.
c′=coffee pot.
d =doll.
k =kiddy-car.
o =observer.
p-c =paper and crayon.
w =wagon.

motion picture of movement trends and also of ideational activity. It does not supply inherent time values as does the cinema film, but it does repay analysis from the standpoint of configuration and content. It is highly revealing as to adaptive behavior as well as motor characteristics. The following graphic data were available for comparative study: drawings responsive to demonstration and to models for copy; drawings of a man; "funny" drawings; free (non-prescribed) drawings; drawings of a house; pencilled maze routes; details and embellishments (circles, elaborations, colors).

Comparative findings in the foregoing fields of drawing behavior are briefly presented and illustrated. Interpretive comment is postponed for summary discussion in a later section.

1. *Responsive Drawing*

The following tabular summary indicates the basic similarity in drawing products in the responsive drawing situations (Table 28).

TABLE 28

RESPONSIVE DRAWING SITUATIONS

80 weeks

Spontaneous drawing: *T* makes a to and fro motion with pencil on paper, similar in general character to that of *C* though more extensive in scope and more approaching the vertical.

Imitates Vertical Stroke: Neither imitates.

89 weeks

Spontaneous drawing: Both scribble and turn paper over.

Imitates Strokes: *T* differentiates circular and vertical stroke; *C* doesn't.

2 years

Imitates Strokes: Both make vertical stroke and neither makes horizontal.

2½ years

(*Excerpt from Record*): "The drawing tests reveal an amazing degree and detail of correspondence. The records themselves are almost duplicates of each other. Both children used the same diagonal weaving stroke in spontaneous scribbling. Both differentiated between the horizontal and vertical strokes without being able to combine them into the cross. Both preferentially made horizontal strokes responsive to the cross test and then reverted to diagonal spontaneous scribbling. Both reverted also to vertical scribbling with finger motion. Both made circular strokes responsively to the circle demonstration."

3 years

Imitates Forms: Each imitates circle. Each imitates vertical stroke. Both fail to copy circle and cross, though *T*'s lines are more single and vigorous, *C*'s more like scribbling.

Porteus Maze: Merely long marks. No adaptive response.

3½ years

Copy Forms: Both imitate and copy cross though *C* a little more accurately than *T*. Both copy circle. Both fail square.

Porteus Maze: *C* keeps within the lines on the first trial; but *T* on both trials and *C* on the second, merely draw around the maze.

Draw-a-Man: Both make circles.

Incomplete Man: Neither adds any parts.

4 years

Copy Forms: Both succeed in copy of cross at third trial. Both make vertical oblongs for square. Both fail triangle.

TABLE 28 (*continued*)

Porteus Maze: Both succeed.

Draw-a-Man: *T* makes a cross; *C* makes a large circle containing three small circles.

Incomplete Man: *T* adds four parts; *C* three.

4½ years

Circle: Both draw circle.

Cross: Both draw one line down, other from left to right.

Square: *T* fails; *C* succeeds.

Triangle: Both fail. *T* draws three-sided roundish figures; *C* draws four-sided oblongs.

Draw-a-Man: *T* makes a circle enclosing eyes, nose, mouth, and adds horizontal hair. *C* draws a circle with eyes, mouth, hair and legs.

Incomplete Man: *C* adds five parts; *T* eight.

5 years

Circle: About the same size for both twins. Each has uneven place where circle starts.

Cross: About equally good.

Square: Each has a four-cornered square, though *C*'s is better.

Triangle: Each fails though *C* puts a little peak on the top side of a square which may be an effort at triangularity. *T* makes a square with the fourth corner slightly modified.

Diamond: Both fail. *T* makes different shaped figures. *C* makes long squares.

Draw-a-Man: Quite a lot alike. Each draws a circle with eyes, and puts in two legs. *T* has more face detail; *C* has arms.

Incomplete Man: Each adds seven parts, though not the same parts.

6 years

Circle: Both draw counter-clockwise.

Cross: Both draw down stroke first, then other stroke from left to right.

Squares: Both make good corners.

Triangle: *T* fails, making irregular squares. *C* succeeds.

Diamond: Both fail though *T*'s figures are diamond-shaped.

Divided rectangles: Much alike, square and eight lines meeting in the center with a large dot.

Draw-a-Man: Each makes a formed body for the first time, two-dimensional. Same number of features except that *C* adds eye-brows. Both add pants. *C*'s legs are two-dimensional whereas *T*'s are one-dimensional.

Incomplete Man: *C* has ten details; *T* only six.

6½ years

Draw-a-Man: Much alike. Each has eyes, nose, mouth, triangular body with buttons, arms with fingers, separate pants, one-dimensional legs and feet.

Incomplete Man: *T* adds 7 details; *C* 8.

7 years

Both succeed on cross, diamond, divided rectangle, hexagon.

2. *Pencilled Maze Routes*

a. (From 3½ to 5 years.) During this early age-period there is a marked and consistent difference between the maze behavior of the twins. *C* throughout gives a "better" performance in terms of success though performances are very similar at 4½ years when both pass diamond and cross. The most outstanding difference throughout is that *C* although she tends to stay within the lines, often fails to trace the entire form, but adds extra marks and decorations. *T* traces the entire form, but often outside rather than within the lines, and adds no extra marks. This somewhat superior performance of *C*'s may be related to her superior behavior in a similar test, the copying of forms, noted at 7, 8 and 10 years.

b. (From 8½ to 10½ years.) The maze test was not given between 5 and 8½ years. Records of behavior from 8½ to 10½ years show performance quite different from that observed earlier. As far as score goes, *T*'s performance was superior to that of *C* at 8½ and 10 years, while *C*'s score was superior at 9½ years. Marked qualitative differences, in keeping with other drawing performance of the twins were observed. *T* throughout drew square corners and straight lines; *C* drew rounded corners and crooked lines.

3. *Ball and Field Behavior*

The twins were given the ball and field test at seven yearly age intervals from 7 to 13 years. At all but two age levels, *T* gave a performance which was definitely superior to that of *C*. However there will be noted an almost exact correspondence between *T*'s 7-year product and *C*'s 8-year product; between *T*'s 8-year product and *C*'s 9-year product, and so on for the first five age levels. This does not necessarily mean that the twins are one year apart in maturity. It indicates rather that they follow almost exactly the same path in their development, with *T* somewhat in advance. It is quite probable that a few weeks after each test, *C* caught up to *T*'s stage and that in the remaining interval *T* made little appreciable advancement. *T* was the first to take the circular path, and *T* was the first to make an additional center excursion after completing the circuit, but it was *C* who first responded with the typical spiral course. The inveterate similarity of their development is emphasized by the fact that *T*'s 10-year product and *C*'s 11-year product, just alike, are both inferior to their respective performances at the age levels preceding.

4. *Draw a Man*

At each examination from 42 months through 12 years, 15 age levels in all, the twins were asked to "Draw a Man." The results of this simple but revealing test are illustrated and summarized below.

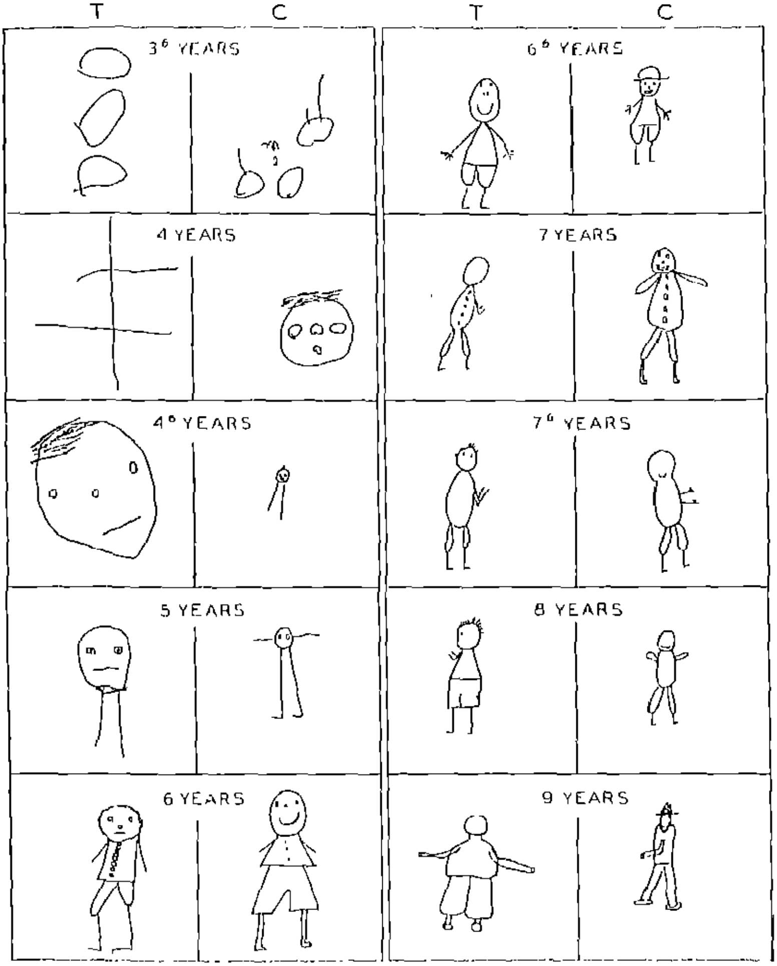

FIGURE 11

"Draw-a-Man": Comparative Products from 3½ to 9 Years of Age

Figure 11 illustrates *draw a man* responses at selected age levels from 42 months through 9 years.

a. Size of drawings. At 6, 7, and 12 years *C*'s drawings are larger than *T*'s. At 11 years they are about equal in size. At the remaining ages, *T* draws a definitely larger man than *C*. *T* verbalizes her concept of bigness at the early age levels, indicating that size is an important factor of her concept.

b. Facial features. *C* included facial features at an earlier age than *T* and continued to represent them after *T* began to omit them. *C* tended to draw a curved mouth, *T* a straight mouth. *C* tended to draw an open mouth, *T* a closed mouth.

c. Details. *T* showed a rather unusual disregard for facial features and tended to draw the man as a whole. *C* represented greater detail of face and clothing.

C was the first to add legs, features including hair, eyebrows, hat and pipe. *T* was the first to represent the eye iris and heels. She was also first to draw profile, to draw five fingers, and to draw the arms bent. The twins represented collar or neckline, buttons, shirt, and pants, at the same age.

A survey of this behavior from the first drawings at 4½ years through 12 years, when rated on the Goodenough scale shows about equal ability. *C* is, if anything, a little superior in that she has a total of 199 points compared with *T*'s total of 180 points. *C* drew more details at 6 age levels, while *T* drew more at 5, but *C* had an average of 4.5 more details than *T* for those ages at which she excelled, while *T* had an average of only 1.6 more details than *C* for those ages at which *T* excelled. It should be said that these ratings exaggerate the discrepancies. The essential similarity was actually extraordinarily great.

d. Comments by twins as they drew.

(1). *Age: 3½ years.* In reply to, "*What is it?*" *T* and *C* both replied, "*A man,*" and indicated by pointing that each had drawn the man three times.

(2). *Age: 4 years.*

T: "*Going to make a man. A big man. Like this?*" Examiner asked, "*What is this?*" pointing first to one cross mark and then the other. *T* replied, "*Big man. Another man.*"

C: "*You going to draw man too?*", pointing to the extra pencil.

(3). *Age: 4½ years.*

T: Spontaneously says, "*This is a nose. Mouth. This is a big baby. Hair.*"

C: In response to questioning. "*Foots, hair, mouth, eye, foot.*"

(4). *Age: 5 years.*

T: Names, "*His mouth, his eye, his feet.*"

C: Names, "*Eye, hand, foot.*"

(5). *Age: 6 years.*

T: Spontaneously drew a little girl. Examiner then asked her to draw a man. "*I don't know how to make no pants.*" Urged to try, she draws and says, "*Shirt, little buttons.*" Urged to finish the man, "*I don't know how to make no pants.*" On urging once more she draws saying, "*Now the legs.*" "*Now the eyes, nose, mouth, and hair.*"

C: Spontaneously drew an Indian. Asked to draw a man she replied, "*I can't.*" Urged, she said, "*I draw him big?*"

(6). *Age: 7 years.*

T draws head, body, legs, feet and arms. When asked if she has finished, she draws an eye. Asked about the other eye, "*It's on the other side.*"

C draws man without arms. When asked if she has finished she draws the arms.

5. *Elaboration and Detail*

The tendencies toward elaboration, detail, and embellishment could also be compared in connection with the incomplete man test and the drawings of a house. The results are summarized in Table 29.

6. *Curvedness of Lines*

This proved to be an interesting and fruitful field of comparison. The drawing of a house naturally puts a premium on straight lines but also releases tendencies toward curvature. In drawing a house, *T* tends to make straight lines, *C* to make curved ones. *T*'s representations of windows and curtains are straight and angular. *C* draws curved curtains. The curtain pulls likewise are straight in *T*'s windows, curved in *C*'s. Smoke coming out of the chimney is curly if drawn by *C*, straight if drawn by *T* (Figure 12).

This difference in lines is also seen in the drawings of bubbles

TABLE 29

NUMBER OF DETAILS INCLUDED IN DRAWINGS

	Incomplete man test
3 years:	*T* makes 2 long lines. *C* makes 7 small lines.
4 years:	*T* makes only 2 marks. *C* makes at least 6 separate marks.
4½:	*T* has more details.
5 years:	*C*'s man is more detailed.
6 years:	*C*'s man is more detailed.
	Drawings of a house
6½:	Much the same. *T* has 2 more windows but *C* has steps.
7 years:	Much the same for both.
7½:	*T*'s house is unadorned but *C* has a tree beside hers.
8 years:	Very marked difference. *T*'s house has only 2 windows; *C*'s has 10 windows.
8½:	*C*'s house has 9 windows, *T*'s only 2. *C*'s door has a window in it and there is curly smoke from the chimney and curtains in the windows. It is much more detailed than *T*'s.
10 years:	Fairly complicated drawings for both, though *C* has more clothes hanging on the line and they are better formed than *T*'s.

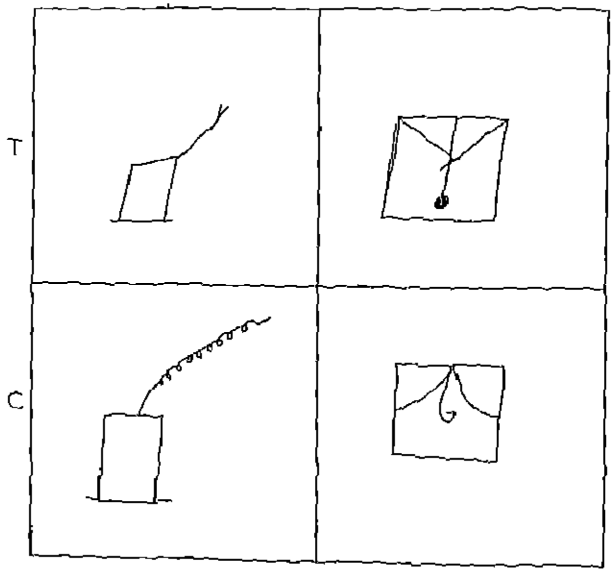

FIGURE 12

CHIMNEYS WITH SMOKE AND WINDOWS WITH CURTAINS

Showing a distinction of rendering typical over a period of many years.

at six years when *T* spontaneously adds a straight appendage, *C* a curved one, to each bubble. Again in the drawings of a man *T* tends to make a straight mouth, in a full-face man (except at 6½ years), while *C* makes a curved mouth.

Circles appear frequently in numerous free drawings, especially as representations of eyes or buttons on the drawings of men, and as curtain pulls or doorknobs in the houses. *T* tends to draw small, filled-in circles, scarcely larger than dots. *C* tends toward larger, wide-open circles. This difference, however, is not observable at all ages. At the younger ages, particularly 4½ and 5 years, both children make open circles. At some of the later ages, particularly 8 and 8½ and 10¼ years, both make closed circles. But at 7 years, *C*'s buttons, doorknobs, and eyes and nose of man are all open circles; *T*'s buttons, doorknobs, and eyes of man are all closed circles. A like difference is seen at 7½, 9, 11 and 12 years.

7. *Use of Color in Drawing*

In many of the drawing situations the twins were given a free opportunity to use a large assortment of crayons. Twin *C* for the most part showed a much better-defined interest in color than *T*. Their utilization of colored crayons at 6, 7 and 12 years will now be briefly compared.

a. At *6 years,* both twins draw human figures standing on grass. *T*'s picture includes four colors only, and color is not apparently the main interest. *C*'s picture has nine colors and the colors in the girl's dress appear to be the main point of interest in the drawing. *T*'s figure is all black and red, has black and red features, a red blouse and black trousers. It stands on green grass and a blue sky is overhead. *C*'s figure also is black and red in outline, with black and red features, but it has black shoes, bi-colored socks, and a striped dress made up of seven different colors.

b. Coloring pictures at 6 years. The twins were given outline forms to fill in with any colors they chose. Each picture was on a separate paper. *T* colored nine pictures, *C*, eleven. *T* colored six pictures all red while *C* had only one picture all red. Each colored one picture all black. *C* had one picture all green. *T* had two pictures made up of two colors each; *C* had three. *C* had five pictures made up of three or more colors while *T* had none made up of as many as three colors.

c. At *7 years,* *T* used six different colors in her drawing, *C* used seven. This is a small difference in actual number, but in the human figures *T* used three colors only, *C* had seven. The body of *T*'s figure and its features were all one color; its blouse was green and a letter in its hand was purple. *C*'s larger figure had an orange head, green body, magenta legs, a red mouth, orange nose, and blue eyes. Other colors appeared as buttons down its front. Thus, though the total number of colors used in the whole drawing is not very different, the distribution of color is distinctive for each.

d. Coloring pictures at 12 years. In coloring four pictures at 12 years there appeared less difference in the number of colors used though *C* still used more, having a total of 25 as against *T*'s total of 22. As judged by three art students, *T*'s coloring was more pleasing, color combinations better, stroking more even, lines steadier, pressure more even, and colors clearer and more finished.

8. *Free Drawing*

Opportunity for "free" drawing was frequently given the twins, supplementing the set drawing situations of the examination. Interesting differences in detail and emphasis are brought out in the four free drawings described below.

The first pair of drawings was made when the twins were seven years old. Twin *T* drew a girl in a library. Twin *C* drew a number of flowers and two people. It is characteristic of *T* to be more interested in books; of *C* to be more interested in flowers and people.

The second pair of drawings was made at nine years. Here again *T* represents a single idea, even though it has plenty of action. A monkey is climbing up a telephone post which stands beside a quite simple house. *C* draws a busy street scene. At an intersection of two streets stands a policeman regulating the activity of three motor vehicles, each of which contains a driver. Two of the cars bear appropriate labels and one has a license plate. Three persons besides the policeman and drivers appear in the picture, and one of the persons is on roller skates. *C*'s interest in details and her interest in persons are well represented.

H. SCHOOL ACHIEVEMENT

T and *C* entered kindergarten at the age of 5 years, 2 months. They were in the same group and had the same teacher. The fol-

TABLE 30

Achievement Scores of Twins *T* and *C*

Test		Age in years												
		6½	7	7½	8	8½	9	9½	10¼	11	12	13	*T*+	*C*+
Oral Spelling,	*T*		1.8	1.7	2.4		3.0	3.1					1	
Grade score:	*C*		1.5	1.7	3.1		3.1	3.7						3
Written Spelling,	*T*		1.8	1.8	2.5	2.8	3.1	3.2					4	
Grade score:	*C*		1.0	1.7	2.8	2.7	2.9	3.4						2
Gray Oral Reading,	*T*		2.6	3.4	4.2		4.7	4.9	5.7	5.4	8.0	7.7	5	
Grade score:	*C*		2.1	2.8	3.6		4.9	4.7	5.7	7.0	7.7	8.0		3
Iota Word List,	*T*	1.6	2.7	3.1	3.9	4.4	4.5	4.7				*	7	
Grade score:	*C*	1.3	1.5	1.9	3.0	3.2	3.4	4.0						0
Wood-McCall Arithmetic,	*T*			3	7	8	17	14		23	24	26	4	
No. correct:	*C*			3	6	10	16	16		19	27	25		3
Trabue Language,	*T*							4		16	13	16	2	
No. correct:	*C*							4		9	14	15		1
Reading Memories,	*T*						8		9	9	9	10	0	
No. correct	*C*						9		11	12	11	10		4
T+ : *C*+		1:0	4:0	3:0	2:2	2:1	3:3	2:3	0:1	2:2	1:3	2:1	23	16

*At 13 years *C* was slightly more competent than *T* on the Gates *Graded Word Pronunciation Test.*

lowing year, in the first grade, they were placed in separate rooms which housed different sections of the same grade. They were promoted each year but placed in different sections until they reached the fifth grade and moved to another district when they were again placed together. Thus from 6 through 10 years *T* and *C* had separate instruction.

School achievement tests have been given the twins at regular intervals with the results to be found in Table 30. From six to eight years *T* scored a little higher than *C* in all of the tests given, but after this age, differences occur first in favor of one twin, then the other. *T* is in general slightly better than *C* in scholastic achievement. In most individual tests now *T* and now *C* tended to excel with inconsistent fluctuations. In the reading of single words, however, *T* was always slightly better and in reading memories *C* was superior. At the age of 13 years even this consistent difference has vanished so far as test scorings indicate.

V. LANGUAGE BEHAVIOR

The language behavior of the twins came under frequent incidental observation, both in the developmental examinations and in the experimental studies, particularly that by Strayer (5). These observations will be briefly summarized under the following headings: (*a*) early vocalization, (*b*) enunciation, (*c*) vocabulary, (*d*) conversation, (*e*) epistolography.

A. EARLY VOCALIZATION

The early records of *T*'s and *C*'s vocal expression are meagre, but it is probably significant that on two examinations when the twins were 16 weeks old *T* was silent whereas *C* vocalized spontaneously and also in the cube situation. During the examination at 24 weeks both children vocalized; no differences were noted. At 28 and 32 weeks *T* vocalized more than *C*, but at 42 weeks *C* was again more vocal. At 42 weeks a record was made of each vocalization. *T* vocalized six times; *C*, sixteen times. Both twins vocalized in protest and while reaching and manipulating test material. *C* also vocalized while standing, but *T* did not. *C*'s vocalizations were more varied and complicated. The actual records follow (Table 31).

At the age of 79 weeks, prior to Strayer's study in language, the following comparisons were made of the twins' vocalizations and response to verbalization:

> Both *T* and *C* vocalized in brief snatches and sometimes reached the level of expressive jargon. Both handed a box to Examiner on command without gesture, and both put the pellet into the bottle on command. Neither child vocalized in a situation in which her twin did not also vocalize at some time during the afternoon. However, Twin *C* vocalized a a little more frequently but *T*'s vocalizations were more likely to have social reference.

Strayer's (5) experiment by the method of co-twin control, conducted when the twins were 18 months old, was designed to compare the relative efficacy of early and deferred vocabulary training. Briefly the procedure was as follows: At the age of 84 weeks *T* was trained daily for a period of five weeks. During this time *C* was kept in a non-verbal environment. At the age of 89 weeks Twin *C* was trained for a period of four weeks and Twin *T* was kept in the non-verbal control environment.

TABLE 31

VOCALIZATIONS OF *T* & *C*: 42 WEEKS

T	*C*
Mmm-mmm-mmm: rhythmic vocalization of impatience when ring is withdrawn and there is a delay before presentation of the next material.	*Mm-mm-mm:* (mouth open) in protest at withdrawal of ring.
	Uh-uh: while banging cubes.
Ah-kha: as seizes handle of cup.	*Thah:* same.
Uh-aah: approaching pellet.	*Da-da-ah-uh, aaah:* very low while banging cubes.
Mmm: again waiting for material.	*Ah-da:* syllables repeated for several seconds. Mild contented vocalizations which quite high break sometimes into crowing as she manipulates spoon.
Gaa: while transferring ring.	
Mmmmmm: impatience when material is withdrawn.	*Ga-da-da:* with sharp upward inflection and evident satisfaction, while picking up cup and bringing spoon to bear on it.
	Aaah: high pitched and long drawn out: crowing during combining activity of spoon and cup.
	Guh-uh: very high pitched, while pursuing pellet.
	Ya-ah: same.
	Trilling in front of mouth during pursuit of pellet.
	Duh: syllable starting very high and with sharply falling inflection (play with pellet).
	Da-da: short accented syllables while banging round block on form board.
	Ah-ha: reaching for ring.
	Gah-da: distinctly pleasurable, during standing.
	Ga-ka-ga: same, standing at crossbar.
	Ah-ii: slight protesting quality in prone position.

The following differences in language behavior were noted by Strayer. Although there was little evidence that the amount of C's vocalizations became less as the experiment proceeded, there was abundant evidence of modification as to the situations in which it appeared and of the increasing disparity between her vocalizations and Twin T's as training progressed. T's vocal expressions during the control period became more social; pure sound play decreased. C rarely vocalized to the Examiner and never used questioning intonation; instead her vocalizations were of the exclamatory or sound play type. C gestured in connection with her spontaneous vocalizations. Mimetic expression independent of vocalization also was developed by C. The evidences of mimetic imitation were prominent only during the control period and denoted an inherent communicativeness.

Although at the end of the experiment Twin C had not caught up to Twin T in verbal expression, a comparison three months after the close of the experiment showed that the differences were disappearing if not entirely gone. C was then using more talkative jargon. Even one month after the end of the experiment the amount, volume, and vigor of utterances were all in favor of C. C applied her vocabulary more frequently and readily than T. However, T's enunciation was more finished.

B. ENUNCIATION

The differences in vocal sounds made by T and C at the age of 42 weeks have already been noted. Strayer commented at the end of her experiment that T's pronunciation was noticeably better than C's and suggested the importance of practice. Strayer had noted that T continued self practice after her training had ended, while C was being trained. Strayer also called attention to qualitative differences in T's and C's pronunciation. T's vowels were more frequently broad and full while C's tended to be flat. Three examples follow:

Word	*T*	*C*
car	că	cä
down	du	da
go go	go go	ge ge

This difference could not be accounted for by any difference in training. T retained this superiority in pronunciation and at 8½ years it was noted that T pronounced *king* as *king*, while C called it *kink*. At the age of 13 years *C* made no distinction in the pronunciation of *Mary*, *merry*, *marry*; while *T* pronounced *Mary* and *merry* as *merry*, but differentiated *marry*.

It should be mentioned in this connection that although the twins were about equal in paragraph reading ability, *T* has consistently made a better score than *C* in reading single words.

C. VOCABULARY

At the beginning of Strayer's (5) study *T* and *C* (age 18 months) each had a vocabulary of one word "up." At the conclusion of the experiment *T* had a total of 40 words; *C* had 30 words (age 21+ months). However, at that age the developmental examination at the clinic disclosed no decided differences in vocabulary. Both twins said *"box"*; both indicated their own shoe when asked *"Where is the shoe?"*; both name the book; and both tended to echo the examiner's questions. Thus the difference in the extent of the vocabulary for which they had been specifically trained certainly had not been widely transferred to general language usage.

During the ages between 2 years 5 months and 2 years 10 months, while the twins' language development was being observed at home, *T* was noted to use verbs describing action sooner and more extensively than *C*. Also *C* would persist in applying her own name for

TABLE 32
RESPONSES TO VOCABULARY TESTS BY TWINS *T* AND *C*

Test	Age in years 4	4½	5	6	6½	7	8	8½	9	9½	10¼	11	12
Detroit B													
Correct responses, *T*	10	11	13	15	17								
Correct responses, *C*	9	8	10	14	17								
Stanford Binet—List 1													
Correct responses, *T*						5	5.5	7	6	11	12	13	14
Correct responses, *C*						5	5.5	5	5	9	11	9.5	12
Correct definition of Five Abstract Words													
T									2		1	2	2
C									0		0	0	1

an object while *T* was more amenable to cultural pressure. For instance, when the twins were repeatedly read *Three Little Kittens*, *C* continued to call the kittens' mittens *slippers* in spite of repeated correction.

At the age of three years when presented with an animal book, *T* named five animals; *C* named four. But on this occasion it was *C* who described action while *T* merely enumerated. From that time on, whenever the twins have been examined, *T* has always excelled, but only slightly on tests of extent of vocabulary. The comparative results for ages from 4 to 12 years are summarized in Table 32.

D. CONVERSATION

Ontogenetically conversation is preceded by jargon; and with conversation comes loquacity. We have a few pertinent comparisons bearing on these aspects of speech. On a May morning, when the twins were 22 months old, A.G. was privileged to witness the following incident.

The twins were playing contentedly with some large building blocks. In an experimental mood tempered with moderate restraint, *C* seized one of the rectangular blocks and brought it to bear on *T*'s head. Indeed, *C* hit *T* three times. *T* began to cry rather vigorously. *C* then began to use jargon in a remarkably conversational manner, phrasing the sounds in a way which suggested sentence structure, in inflection and form. This jargon suggested definitely an effort at conciliation. Each such vocalized effort met with a prompt "No" and a negative gesture by *T*. This "No" was repeated two or three times and twice *T* said rather distinctly, "*Bad girl.*" *C*, in sweet tones, resumed her persuasiveness, but there was no formal reconciliation. After a few minutes, however, they were playing together with the blocks as though nothing had happened.

The jargon stage soon disappeared. With the establishment of speech, which twin proves to be the more loquacious? The answer is found in Table 33 which records our comparative judgments based upon the actual amount of talking heard while the twins were under observation between two and five years. At the age of five years and thereafter the judgment is based on the recorded verbal responses to the four Stanford-Binet pictures.

The above evidence indicates that in general *C* is the more loquacious child, but that on occasion *T* does talk more. On two of the six occasions when *T* was found to be more talkative, she was reported to ask more questions.

TABLE 33

Age	Judgments as to loquacity	Loquacity in favor of
2 yrs. 4 mos.	Mother reports *T* more talkative; *T* asks more questions.	*T*
2 yrs. 5 mos.	*C* more talkative.	*C*
2 yrs. 6 mos.	*T* more talkative.	*T*
2 yrs. 8 mos.	*C more active and talkative.*	*C*
2 yrs. 8 mos.+	*C* more talkative.	*C*
2 yrs. 9 mos.	*C* more talkative.	*C*
2 yrs. 9 mos.+	*C* more talkative.	*C*
3 yrs.	*C* more talkative.	*C*
3 yrs. 1 mo.	*C* more talkative.	*C*
3 yrs. 2 mos.	Words during play: *T* 123; *C* 263.	*C*
4 yrs.	*T* talked more; asked more questions.	*T*
4 yrs. 6 mos.	*T* talked more; appeared more at ease	*T*
5 yrs.	*C described pictures more fully.*	*C*
6 yrs.	*T* described pictures more fully.	*T*
7 yrs.	*T* described pictures more fully.	*T*
8 yrs.	*C* described pictures more fully.	*C*
10 yrs.	*C* described pictures more fully.	*C*
11 yrs.	*C* described pictures more fully.	*C*
12 yrs.	*C* described pictures more fully.	*C*

E. *Epistolography*

When *T* and *C* were seven years old, we asked them to write two letters, one to A.G. and one to J.R.H. At this time *C*'s penmanship was larger than *T*'s. *C*'s writing filled the two sheets of paper given her for the two letters, but *T*'s covered only a little over half of each sheet. Nevertheless both of *T*'s letters were longer than *C*'s in content (Table 34).

TABLE 34

Number of Words in Letters Written

	T	*C*
Letter to A.G.	56 + P.S. 22	16
Letter to J.R.H.	47	20

A slight difference in social attitude and finesse of expression was noticeable.

T to J.R.H.

> Why don't you come and see us sometime if you will come over to my house sometime I will be glad. I think if you will come over my sister will be glad. I wish you will write a letter to. My sister wrote a letter to.

C to J.R.H.

> I didnt see you for a long time I wanted to see you are you working are you feeling good.

T's letter is more direct, specific, and shows less concern for the recipient. *C*'s is more subtle, pleasing, and shows more concern for the recipient. Their letters to A.G. showed the same differences.

Since the above letters were written, the twins have of their own accord written us on 14 occasions. On 10 of the 14 occasions the letters have been written by *C*. *T* alone wrote on only two occasions. On two occasions *C* wrote to A.G., while *T* wrote to H.T.

VI. PERSONAL-SOCIAL BEHAVIOR

A. Response to Training and Home Environment

T and *C* received no consistently different treatment up to the age of 46 weeks. They were first in a hospital and then in a child care institution. As normal, healthy, attractive twins they were each given more than ordinary attention, but neither appeared to be favored. In fact, as infants they were so easily confused that if we had not had their palm prints we might fear that in some unguarded moment they had been confused. The nursery used adhesive tape encircling the wrist of Twin *T* for identification purposes.

Just prior to 46 weeks of age, *T* and *C* were both isolated from their ward mates due to a mild infection. *T* was released sooner than *C*. While *C* continued her solitary isolation for a brief period, *T* was returned to the nursery. *T*, moreover, daily received 20 minutes of individual attention while she was trained (by H. T.) in stair climbing and cube play, an arrangement which continued for six weeks. That *T* responded to this special attention was shown by the fact that *T*'s responses to H. T. became so vivid that it was possible to distinguish *T* from her co-twin "by the outgoing gestures of social greeting." (Although H. T. has been deliberately impartial to the twins, *T* still elects H. T. when choosing a partner.)

C's delayed training at the age of 53 weeks was only 10 minutes in length as opposed to 20; and was continued for only two weeks. However, even during this short period *C* became socially so responsive that on occasion *T* and *C* were mistaken for one another. During this experiment although the twins were at times equally responsive, *T* continued to be more outgoing, more vivid and more reactive in social situations than *C*, particularly with reference to H. T.

It was not surprising then that at the age of 18 months, just prior to Strayer's experiment, that *T*'s vocalizations showed more social reference. In Strayer's language study *T* was again the first to be trained, and during her training *T* spent 4½ hours a day with L.C.S. as contrasted with *C*'s 2¼ hours. Although every effort was made to make the non-verbal environment of *C* as social as the verbal experiences of *T*, the very nature of the language training resulted in more intimate social stimulation for *T*. During the experiment *T* and *C* "minded" equally well. No special disciplinary measures were necessary for either.

At the age of 26 months the twins were taken home, where their newly acquired stepmother, unfamiliar with small children, had difficulty with discipline. *T* became prankish and received more punishment while *C* was favored and pointed to as the model. *C* was talked to more and was also held more often in the lap. On advice, the mother became less discriminating but has continued to favor *C*.

When *T* and *C* were eight years old, a half-sister was born. Neither child showed any evidence of jealousy. *C* was more communicative about the sister and referred to her accomplishments as she developed more than did *T*. The sister has likewise responded more positively to *C* than to *T*. It is *C* to whom the sister goes when in trouble and it is *C* who can more easily quiet her. As the twins grew older, it was *T* who preferred to stay overnight or spend the week-end with her grandmother or aunt, while *C* preferred to stay at home and help care for the young sister.

While it is *C* who talks about her sister, and tells of their grandmother's illness and death, it is *T* who answers factual questions.

A recent report of the twins home behavior was given as follows by the stepmother: *C* has more patience than *T* with their younger sister. The sister will always go to *C* rather than to *T*. In the home *C* is the more sympathetic, more affectionate, and more obedient. *C* is also neater: when *C* starts a task she finishes it, but *T* does not. *C* made a crocheted lace cover for the table; *T* started to crochet a wool afghan but tired of making it and showed her mother how it could be finished. At home *T* spends more time reading than does *C*. *T* appropriates the Sunday paper.

Both twins belong to the 4H Club and are equally proficient at their dress-making and cooking tasks, but it is *C* who helps *T* with an intricate or dextrous bit of sewing. Clearly it is *C* who fits into the home better than *T*, while it is *T* who finds her greater interest outside the home.

B. SOCIALITY OF ATTENTION

A previous chapter made note of certain differences in the distribution of attention displayed in relatively impersonal behavior situations such as cube construction. But no behavior situation is entirely impersonal when there is someone around. The twins have been rarely alone as individuals. Nearby there has always been a co-twin, and not infrequently an observer or an examiner. It now becomes pertinent to ask how *did* the twins compare with respect to their attention to a nearby person, whether co-twin or adult.

Fortunately the cinema records furnish irrefutable objective evidence in answer to this question. Many feet of film were carefully analyzed (by L.B.A.) to determine the moments and amount of diversion of attention from the task in hand to a person. The accompanying graph is based upon the records of developmental examinations made at eight age levels from 28 weeks to 33 months. The total comparable examination time was determined, and then the per cent of total time spent in *looking at the examiner* was computed. *Under the uniform and highly controlled conditions of these examinations*, the figures must be regarded as furnishing a significant index of sociality of attention (Figure 13).

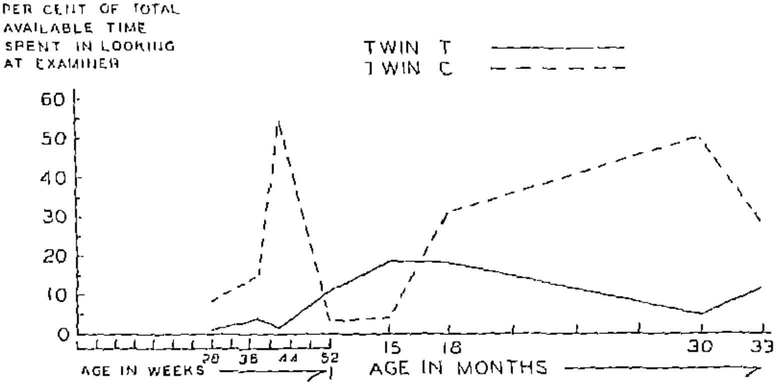

FIGURE 13

COMPARATIVE TIME SPENT IN REGARDING EXAMINER

Cinema records of eight age levels were analyzed and quantified to determine *the amount of visual attention to the examiner. One or more identical* situations were compared and averages calculated at each age where measurable differences occurred. The graph shows the *percentage of total time spent* in looking at the examiner.

1. *Attention for the Examiner*

The graph shows that at only two ages (12, 15 mos.) *T* spent more time looking at the Examiner than did *C*. Almost invariably at other ages *C* spent at least twice as great a proportion of the available total time in looking at the Examiner. This is not to be interpreted as negative behavior. It represents a disposition of attention.

2. *Attention for Co-twin*

Not only the Examiner receives a good share of *C*'s attention. Her social regard also wanders from the stimulus test object to her co-twin. But the reverse of this does not hold. *T* is as sparing of her social regard for her co-twin as she was of attention for the Examiner.

A summary view of the extent to which *C*'s attention to *T* exceeds *T*'s attention to *C* may be obtained from Table 35. The table is based on cinema and stenographic records. A check indicates in each instance which twin paid the most attention to the other.

3. *Social Regard in the Pellet Situation*

At the age of 38 weeks, a sequence of 46 seconds of pellet behavior was recorded by cinema. A chronometric film analysis tabulated in parallel columns, reveals the interesting fact that *T* regarded the examiner for 1.12 seconds as opposed to 4.52 seconds for *C* (Table 36). This record is typical of *C*'s greater social permeability. The table also brings out the fact that *T* spends more time in actually directing hand movement toward or manipulating the pellet (45 seconds out of 47), whereas *C* directs movement toward or manipulates the pellet only 32 seconds out of 47.

4. *Social Aspects of Stair Climbing*

A similar analysis of stair-climbing behavior (at 80 weeks) reveals the same characteristic differences with respect to social reference (Table 37). *T* climbs the stairs and pays no attention to *C*. *C* attends to *T*, and spends five times as much time in looking at the examiner as does *T* (11.42 seconds versus 2.30 seconds out of an available 23 seconds.)

5. *Social Reference in Performance Tests*

The difference noted in the infant examinations is detectible in the cinema records of performance test situations at the age of 13 years as shown by the following comparative tables (Tables 38-39). At the last of these examinations it was noted that *C* not only smiled oftener; she smiled more broadly. She looked up at one of the Examiners, smilingly, after nearly every situation. This behavior was not seen in *T*.

TABLE 35

Twin Regarding Co-Twin Most

Age:	28 wk.	38 wk.	42 wk.	52 wk.	84 wk.	2 yr.	2½ yr.	3 yr.	5 yr.	6 yr.	8 yr.	9 yr.	9 yr.+
T		*[1]		*	*[1]						*[2]		
C	*	*	*		*	*	*	*	*	*		*	*

[1] At 38 and 84 weeks behavior varies in different situations.

[2] Based on school teacher's report.

TABLE 36

SOCIAL REGARD AND PELLET BEHAVIOR, AGE: 38 WEEKS

T	*Time in Seconds*		*C*
Reaches for *C*'s pellet	0.00	0.00	Reaches for pellet
Looks at own pellet	1.62	1.62	Looks at *T*'s pellet
Reaches for pellet, rt. hand	4.68	4.30	Still regards *T*'s pellet
Scratches at pellet	5.00	5.24	Looks at her own pellet
		6.12	Looks at Examiner
		7.12	Looks at Examiner's hand
Still scratching at pellet	8.55	8.06	Looks at pellet
		8.62	Looks at her own hand
Closes hand on it	9.00	9.30	Looks at Examiner at left, until
Reaches for it again	11.42		
Doesn't pick up though hand closes on it	12.24	12.75	Looks back at pellet
Finally succeeds in		13.62	Looks over at *T*
picking it up	15.36	15.62	Looks at pellet
Regards pellet in hand	16.00		
Taps pellet on table top	17.06	18.56	Reaches for pellet with right hand
Brings pellet to side rail	20.24	20.12	Places hand over pellet
		21.06	Closes hand but misses pellet
Starts to lift to mouth	22.06	22.56	Hand over pellet again
Lowers toward table top	22.68	23.30	Points at pellet
Looks at her left hand	24.56		
Looks at pellet, at rt. hand	26.50	26.06	Fingertips to pellet
Loses pellet in lap and		27.62	Withdraws hand
looks for pellet	30.81	29.06	Reaches for pellet again
Looks at pellet, re-presented	31.18		
Reaches for, left hand	32.62	32.00	Closes hand on pellet and picks up
Puts left hand on pellet	33.24	33.62	Opens hand and drops pellet
Pokes at pellet	35.12	36.62	Regards pellet or hand
Scratches table top	37.81		
Hand reapproaches pellet	39.12	39.68	Looks at re-presented pellet
Scrapes pellet toward self	40.68		
Draws off table top in fist	41.56	42.00	Reaches for with left hand
Puts hand, with pellet, behind her and regards Ex.	45.50	44.00	Scratches at pellet but misses
Looks back to table top	46.68	46.50	Pokes at pellet, contacting it
Situation ends at 47.00			

C. SOCIABILITY

In early childhood both children were unusually trainable and generally good subjects for study. Now one and now the other would develop a teasing spirit but in general *C* a little more frequently than *T* has been given to playful teasing.

Their response to other children has been observed on many oc-

TABLE 37

COMPARATIVE ANALYSIS OF STAIR CLIMBING BEHAVIOR, 80 WEEKS

T	*Time in Seconds*	*C*
Starts to climb stairs	0.00	Looks at Examiner. Doesn't climb
Both feet on stair one	1.56	Looks at *T*
Both feet on stair two	3.42	*Looks at Examiner, at T, at Examiner*
Both feet on stair three	6.36	Watches *T*
Both feet on stair four	9.00	Looks at *T*
Looks at Examiner	9.06	Turns and looks toward camera
Climbs onto crib platform	12.56	Still looking at camera
Regards doll on platform	13.00	Looks at Examiner
Moves about on platform	17.00	Starts toward stairs
Lies prone on platform	18.12	Looks at Examiner
Prone, looks at Examiner	21.30	Starts to climb stairs
Looks at Examiner who places her sitting	23.36	Has reached second stair
	Situation ends at 23.36	

TABLE 38

COMPARATIVE ANALYSIS OF FREE CONSTRUCTION WITH CUBES, 13 YEARS

T	*Time in Seconds*		*C*
Cubes presented	0.00	0.00	Cubes presented
Regards cubes	0.06	2.06	Looks at *T*
		4.50	Regards cubes; smiles
Starts to build	8.42	13.87	Smiles at Examiner
		22.00	Starts to build
		35.24	Finishes simple structure
		35.30	Hands in lap
Finishes complex structure	40.00	40.00	*Looks at twin*
Looks at cubes	40.62	42.00	Looks at cubes
	Situation ends at 47.56		

Distribution of regard

	T	*C*
Looks at Examiner	.12 sec.	8.56 sec.
Looks at Co-twin	.50	3.50
Looks at Cubes	42.68	33.42

TABLE 39

ANALYSIS OF REGARD DURING WHOLE CINEMA, 12^{11} AND 13^{4} YEARS

		T	*C*
12^{11} years.	No. times regards Examiner	1	2
	No. times smiles	1	6
13^{4} years.	No. times regards Examiner	22*	23
	No. times smiles	9	20
	No. times regards Co-twin	2	3

**T* looks up gravely for instructions.
C looks up and smiles at Examiner.

casions. When they were 3 years, 3 months, old they were each brought at different times into a room where a child of their own age was playing with a doll carriage. *C* struggled for the possession of the carriage, offered the child a "cup of tea" to distract her, and finally secured the carriage. *T* made no attempt to get the carriage but helped the child take it down the steps and the two played cooperatively with the dishes.

Their second grade teachers reported that in the play yard *T* sought out *C* and played with *C*'s friends. *C* was more of a leader and more aggressive. She was less shy and more likely to mix with other children than *T*. *C* was also considered not as sensitive as *T*. Neither showed any signs of jealousy and both were sympathetic. *C* worried particularly if another child did not have the necessary equipment for games.

In the seventh grade, their teacher reported that *T* and *C* were well liked by the other children who were proud of the twins. She thought that the class would resent it if the twins were scolded. Usually she observed more children around *C* than around *T*. *C* was definitely more popular with the boys, one of whom helped her with her grammar in which she was behind the rest of the class. *C* sent him three valentines in the spring! Boys sitting near *T* received no special attention from her.

T was more sober and depressed than *C*, so their teacher considered how she might remedy this. She called *T* to her and asked whether she had any special friend. *T* said that she did not have one, that she liked all the pupils. The teacher then suggested that she herself would be *T*'s special friend. *T* beamed at the idea and her mood became brighter. Her classmates apparently noticed a change, for when they were discussing the radiance in George Washington's portrait one of the pupils commented, *"When the twins first came here to school it was C who smiled more; now T smiles more."* Just at this time *T* was chosen as sprinter on the school team while *C* did not run fast enough to make the team. This further stimulated *T* so that on her following visit to the Clinic she was even more animated than *C*.

A few supplementary observations bearing on social independence may be added. Beginning at the age of 79 weeks both twins were fearful of strangers and of being alone. At 79 weeks of age *C* was more disturbed than *T* by a strange situation but this difference may have been conditioned by *C*'s isolation because of an infection. On their clinic visits both twins cried so lustily when put in separate beds for their noon nap that they were allowed to rest together. They quieted in a similar manner when reunited. Up until school *age they could not be left alone even though together, without being* very disturbed.

When the twins were 3 years, 3 months old, their mother reported *C* to be the braver. *"She would have gone out in the dark when T would not."*

At the age of 3 years, 11 months, both children showed fear of their kitten and both slowly overcame this fear. When they were about 12 years old *C* was afraid to stay with her sick grandmother, dreading that she might die, while *T* did not share this fear. But it must be remembered that *T* had formerly spent more time with her grandmother while *C* preferred to stay at home to mother her younger sister.

D. INTER-TWIN DOMINANCE

Whenever two or more are gathered together, the problem of rivalry and dominance emerges. This is true even of twins as alike as *T* and *C*. In this pair the similarity is so thoroughgoing that the equipoise is almost perfectly symmetrical. Rivalry and dominance are *lost in reciprocal imitativeness and mutual adaptation.* Dominance is subtle and inconspicuous. Even persons well acquainted with the twins arrive at their judgment reflectively and not very emphatically. A table of judgments as to dominance follows (Table 40).

TABLE 40

Age of twins in years	Judgment by	Comment
2½	M.P.	"*C*'s attitude more dominating."
3	G.H.	"*C* is the more aggressive and the more talkative; domineering would not be the word for she is too quietly dictatorial in her manner."
4 2/3	Mother	"*C* dominates *T*."
6	A.G.	"If anything *C* was the dominant twin."
8	Teacher	"*C* is the leader."
10	M.M.	"If either twin takes the lead I would be inclined to say it was *C*."
12	O.	"*C is the dominant* twin."
12½	Mother	"*T* always waits for *C* to start."
13	H.T.	"*C* presents herself for measurement first."

Although the degree of dominance is very slight, it is significant that all the judgments without exception point to *C* as the dominant twin. There is, actually, a great deal of "give and take" between *T* and *C*. It should be noted that it is *T*, not *C*, who gives the cue in tap dancing, and it is *T* who manages their community purse and it is *T* who is less confused about directions. Yet in spite of this it is *C*, the more social child, who appears to dominate her otherwise more able twin.

An excellent example of the personal interaction of *T* and *C* is provided by a continuous record of their behavior in one of the observation rooms of the nursery when they were 3½ years old. The record covers a period of seven minutes, and all of the vocalizations verbal and otherwise are included in the parallel column inventory (Table 41).

Inspection of Table 41 shows that *T* is motorwise more active. She moves about more and handles the physical objects in the environment to a greater extent than *C*. Socially, however, *C* dominated the situation. On six occasions she gave orders to her co-twin. *T* gave only one order. *T* complied four or five times with *C*'s orders, only once did she rebel, saying *"No no"* and turning to the adult observer (*O*) seeking a way out. *T* was emotionally more expressive, screaming, shouting and laughing. *C* was relatively more controlled. But that a fundamental reciprocity prevailed is clearly shown by the fact that *T* trundled *C* and *C* trundled *T* in the baby carriage.

An example of the way in which *C* manages this domination is pertinent. The twins at age 12 years were waiting for their father to take them home. *T* picked up a book of riddles and read them, making *C* guess the answers. Finally *C* asked for her turn, took the book and asked *T* the riddles but left out a clue in each so that *T* had difficulty in answering. Another method used by *C* is that of passive resistance. *T* was sleepy one evening and wanted to go to bed, but she was unwilling to go to bed alone. *C* did not give in and finally *T* went to sleep in her chair. Undoubtedly it is *C*'s more passive as well as more social nature which makes for her more effective domination.

E. PRODUCTIVE HUMOR

Reference has been made to the greater propensity to tease observed in *C*. This tendency may be correlated with a greater fund of humor. At 7½ years, 8, 8 years 10 months, and 9 years of age *T* and

TABLE 41

FREE PLAY SITUATION ILLUSTRATING INTER-TWIN DOMINANCE

<table>
<tr><td>*Age:* 3½ years</td><td>*Time:* 2:32 p.m.-2:39 p.m.</td></tr>
<tr><td colspan="2">Carriage, table and chair in room.</td></tr>
<tr><th>Twin *T*</th><th>Twin *C*</th></tr>
<tr><td>*T* grabbed the carriage.</td><td>*C* pulled the table towards the screen. Said, "Help me carry it." *T* complied.</td></tr>
<tr><td colspan="2">Both pulled the table, turned it upside down.
One twin crawled inside it.</td></tr>
<tr><td>*T* cried loudly.</td><td></td></tr>
<tr><td colspan="2">*Observer: "Get it up straight."*
Table was turned aright.</td></tr>
<tr><td></td><td>*C* cried, *"My baby! My baby!"*</td></tr>
<tr><td>*T* screamed. Ran to carriage.</td><td></td></tr>
<tr><td>*T* sat inside the carriage.</td><td>*C* pushed her twin in the carriage.</td></tr>
<tr><td>*T* got out.</td><td>*C* sat inside the carriage.</td></tr>
<tr><td>*T* pushed her twin in the carriage, up to *O* who stood looking out window.</td><td></td></tr>
<tr><td>*T* walked to the table, put the chair under the table.</td><td></td></tr>
<tr><td>*"Now you get in."*</td><td>*"Now you get in."*</td></tr>
<tr><td>*"Wait till I push the chairs."*</td><td></td></tr>
<tr><td></td><td>*"Put the carriage here. Come on."*</td></tr>
<tr><td>*T* complied with *C*'s request.</td><td></td></tr>
<tr><td colspan="2">Both pushed the table.</td></tr>
<tr><td></td><td>*C* sat inside the carriage.</td></tr>
<tr><td>*T fitted C's dress in the carriage.*</td><td></td></tr>
<tr><td>*T* pushed her twin in the carriage.</td><td></td></tr>
<tr><td></td><td>*"Get in there."*</td></tr>
<tr><td>*"No, no."* *T* walked around room.
To O: "I want a drink of water."
To O: "I want to see out."
O picked her up to see out the window.</td><td></td></tr>
<tr><td></td><td>*"Come on. You sit down."*</td></tr>
<tr><td>*T* complied, and climbed into carriage.</td><td></td></tr>
<tr><td></td><td>*"You be the baby."*
C pushed her twin in the carriage.</td></tr>
<tr><td>While being pushed, shouted, *"Girl. Girl."* to *O*.</td><td></td></tr>
<tr><td></td><td>*C* took *T* out of the carriage.
C climbed in, got out, got back in.</td></tr>
<tr><td>*T* dumped her twin out of the carriage and laughed.</td><td></td></tr>
<tr><td></td><td>*"Going bye-bye."*</td></tr>
<tr><td colspan="2">Left the room with *O*.</td></tr>
</table>

C were asked to draw a funny picture. At 7½ years *C*'s picture and her explanation was definitely the more humorous to an adult. This and their subsequent drawings of funny pictures are described briefly, as follows (Table 42). Drawings at 7½ and 8 years are illustrated in Figure 14.

TABLE 42

RESPONSES TO "DRAW A FUNNY PICTURE"

T	*C*
Age: 7½ years	
Drew two boys, bristly hair, each holding a balloon. She said, "*The hair is funny.*"	Drew a boy and a house. The boy appeared to be grinning. She said, "*This boy is supposed to go to school but he is going home.*
Age: 8 years	
Both children drew a child going home instead of going to school. (*C*'s funny picture at 7½ years had been laughed at while *T*'s had not!)	
Age: 8 years 10 months	
Drew a house tipped over on one side. She said, "*The house is almost falling down and the people are still living in it.*"	Drew a boy holding something at arms' length. She said, "*The boy when he goes to school doesn't hold his book in his arm—holds it in his hand. Instead of going to school he goes home.*"
Age: 9 years	
Drew "*An old lady who has long hair and her hair isn't combed and she has a cane.*"	Drew "*A man who hasn't any eyes.*"

TABLE 43

T	*C*
Sad picture	
Drew a girl crying with arms hanging down at her side. It was sad because "*The girl was walking along the street crying because a boy threw stones at her. He was throwing stones in the air and one hit her on the head.*"	Drew a boy with arms raised. It was sad because, "*The boy's lost his way.*"
"Draw What you Like Best."	
Drew an apple with a stem. "*I like an apple best because it's sweet.*"	Drew a house. "*I like to draw that the very best because I like to draw lines and try to make them straight.*"

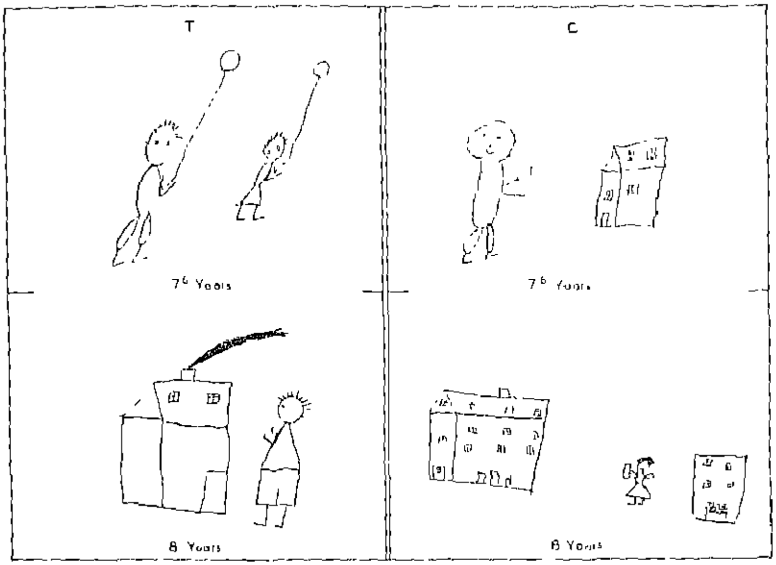

FIGURE 14
"DRAW A FUNNY PICTURE": COMPARATIVE PRODUCTS AT 7½ AND 8 YEARS

Neither twin shows much humor in her drawing. Any differences which may be formulated are too interpretive to receive comment.

At the age of 8 years 10 months, by way of contrast, *T* and *C* were also asked to draw a sad picture and then a picture of what they liked best, with the result indicated in Table 43.

F. PHANTASY

The power of producing associations and creating imagery was tested by means of the Kent-Rosanoff *Association Test* and by the Rorschach *Test*.

The Kent-Rosanoff *Association Test* was given to *T* and *C* at 8, 9, and 10 years 10 months. Identical responses were given to the 100 words as follows: at 8 years, 16; at 9 years, 24; and at 10 years 10 months, 27. *T*'s responses tended to be more usual than *C*'s as shown by the comparison in Table 44.

It was also the subjective impression of the examiner that *T*'s as-

TABLE 44

	Twin *T*			Twin *C*		
Frequency of response at	8	9	10^{10} years	8	9	10^{10} years
Under ten	35	32	10	66	36	23
Over one hundred	35	45	44	20	39	36

sociations were the more obvious while *C*'s were more difficult to understand. Between the ages 9 years and 10^{10} years, *T* changed her response in three out of four instances; whereas *C* changed hers in only one out of four instances. However, neither twin could be said to show any significant deviation from the normal. Just as *C*'s funny drawings needed her interpretation to make them funny, so her associations on this test would be better understood if her association were explained. They were unusual but they did not suggest a disturbed personality.

Now, at the age of 13 years, *T* appears to make her adjustments by assuming a don't-care attitude and turning to another interest, while *C* makes greater effort to conform. (Their mother reports that if anything goes wrong, *C* puts her head down while *T* pretends not to care.) Whether these differences are a matter of circumstance or genuine individuality can only be a matter of speculation. The more self-centered interest of *T* is also evident in her wearing of jewelry which *C* has never displayed to a similar extent.

When *T* and *C* were 10 years 10 months old, and again when they were 12 years old, the Rorschach *Test* was administered. Their responses were scored as given in Table 45.

Their responses at 12 years were more similar than at 10 years, 10 months. Although at 12 years their responses were very similar, characteristic differences were apparent. On each occasion *C* gave the greater number of whole responses; *T* the greater number of detailed responses. *C*'s responses were, less frequently than *T*'s, related to form; *C*'s were, more frequently than *T*'s, related to movement.

T's and *C*'s responses to the third picture of the Rorschach series are typical of these differences (Table 46).

The test responses at 10 years, 10 months, of age have been subjected to a blind analysis by William and Mariam Orbison, both of whom have had experience with the Rorschach. They judged *T* to be the more direct, and the more easily confused; while *C* was judged the more intelligent, the narrower in her interests, the more imaginative,

TABLE 45

RESPONSE TO RORSCHACH TEST

	Age in years			
	10^{10}		12	
	T	*C*	*T*	*C*
Number of responses	22	19	21	23
Stimulus selected (%)				
Whole	4	16	5	8
Detail	92	79	95	87
Detail, ordinary	4	0	0	0
Detail, rare	0	5	0	4
Determinant (%)				
Form	86	21	66	56
Movement	0	10	9	9
Movement-form-color	0 } 0	5 } 62	0 } 9	4 } 17
Form-movement	0	47	0	4
Color-form	4	5	9	4
Form-color	9	5	0	9
Chiaroscuro-form	0	0	9	0
Form-chiaroscuro	0	0	0	4
Chiaroscuro	0	0	0	4
Color space	0	5	5	4
Content				
Human	0	16	5	9
Human detail	4	0	0	0
Animal	41	57	24	26
Animal detail	0	0	5	9
Objects	32	0	5	4
Others	13	*26*	*60*	*52*
Miscellaneous				
Per cent of F+	56-61	61-82	78-81	38-73
Movement: Color	0:2	2:2	3:2	3:2
Per cent popular response	4	15	9	17
Per cent space responses	4	*0*	*0*	*0*

TABLE 46

RESPONSES TO PICTURE 3 OF THE RORSCHACH SERIES

T	*Age: 8^{10} years*	*C*
"Middle of a red butterfly." "Two sides black, *looks* as though branch of a tree." (Turns it *sideways*). "Dog with a long *tail*."		"Two birds trying to get a bug, *looking* at each other."
	Age: 12 years	
"Lions" (upper side). "Thing of cotton" (*lower* center.) "Skeletons" (figures).		"Two birds and there's a ribbon in *the middle. Both want it. Putting hands into a tub.*"

the more interested in people, the more perseverative, the better adjusted, the more concerned about separation from her co-twin, the more moody, and the more dominant twin.

G. SELF ESTIMATES OF PERSONALITY TRAITS

When the twins were 9½ years old they were deemed to have sufficient insight to use a self appraisal rating scale. They were given Rogers' *Test of Personality Adjustment,* in which the subject rates herself on a scale of from one to ten as being like or unlike, and as desiring to be like or unlike, a certain standard. The results of this test follow.

T was more conservative in her responses and tended to rate her ideal nearer to herself. She made an average difference of 1.5 points.

C was more extravagant in this respect and she showed an average discrepancy of 3.00 points. In general their replies were highly similar; both scored low on personal inferiority and average on family adjustment; *C* was average on social adjustment, *T* was low; *C* was higher than *T* on daydreaming score (Table 47).

TABLE 47

	T	*C*
Personal adjustment	6 low	7.3 low
Social maladjustment	7 low	11 average
Family maladjustment	7.5 average	8 average
Daydreaming	5 average	6 high

Differences in responses to the specific questions reveal personality differences highly consistent with the sum total of the examples of personality manifestations. *T* wants to be a (*a*) teacher, (*b*) storekeeper, (*c*) nurse. *C* wants to be a (*a*) teacher, (*b*) princess, (*c*) singer.

These probably represent true differences. It is significant that each wants primarily to be a teacher. Their second choice illustrates *T*'s practical nature and *C*'s imaginative tendencies. The third choice emphasizes differences which are actually realized. *T* stayed with her grandmother when she was ill; *C* has more talent in singing and whistling.

The only member of her family whom *T* would take with her to a desert island is her little sister, Marie; while *C* chooses only *T*. Another question relating to friends shows that *T* wants a few good friends, while *C* wants many; also *T* considers that she has a few good friends, but likes best to play with a crowd. *C* considers that she has many friends, but likes best to play with one or two others.

Another answer which may be significant is that *T* thinks one has the most fun in life when a young child; while *C* thinks there is most fun between 9 and 12 years. Was *T* happier when she was younger than she is now? It is true that she was formerly more exuberant than *C*, while now she frequently seems a little depressed.

C rates herself higher on prettiness than *T* rates herself. *C* really is prettier and probably has heard others comment. *C* also rates herself higher on the question of brightness than *T*. *C* also indicates greater aspirations to brightness than *T*. Is this an evidence of *T*'s "don't care" attitude? Both twins think that their father's approbation would be won first by good school marks. *C* thinks her mother would be influenced most by prettiness. *T* thinks her mother would, like her father, be influenced most by good marks.

The only other difference in the test was with respect to day-dreaming. *T* rated herself average; *C* rated herself high. We have already noted that *C* wished to be a princess, as her second choice. These replies are consistent with our impressions of the two children.

Their attitude toward boys is shown by the following: *T* rejects the notion that boys like her; *C* does not accept or reject the notion. *T* would not like to be a boy; *C* is indifferent. *T* rejects the notion that she has lots of boy friends; *C* does not reject or accept the notion. Both children definitely do not wish to have boy friends. Both children think that girls like them better than boys.

The fact that in general *C* was more extreme in her estimates than *T* makes the above differences with respect to attitudes about boys significant. *C* evidently has a more positive attraction for the opposite sex than *T*. That this is true is borne out by the fact that *C* now has a boy friend, while *T* who has had the same opportunities to develop boy friendships has not done so.

VII. COMPARATIVE CHARACTERIZATION

A concise comparative characterization of the twins will bring into focus the differences which it is our chief task to interpret in the concluding chapter. Such condensed characterization will inevitably tend to exaggerate the magnitude and extent of the differences. The reader must again be reminded that the differences which have been established by long and zealous inquiry finally prove to be so slight that they would be set down as similarities if they were encountered in a study of unselected children or even of ordinary siblings. But *T* and *C* are extraordinary siblings, indeed, and the very completeness of their identities imparts added significance to any stable difference, however slight, which can be firmly validated.

A. Physical Characteristics

Almost indistinguishable in appearance, both in countenance and physique, *T* was slightly taller at every age except at 3 years and at 11½ years, when *C* measured taller. In body conformation *C* is stockier by measurement if not perceptibly. Throughout the first nine years, except on three occasions, *C* also weighed more than *T*. Thereafter *T* became and remained heavier. At birth the weight difference was only 3 ounces (Twin *T*, 5 pounds 6 ounces; Twin *C*, 5 pounds 3 ounces).

The prepubertal crossing of the weight curves is undoubtedly correlated with a small but consistent degree of relative acceleration in *T*, evidenced in the fact that the first tooth came first in *T*; her permanent teeth likewise erupted earlier; and menarche arrived sooner. If speed is an advantage, the tempo was in her favor; but the two melodies remained the same: the order of dentition (which is the equivalent of maturational melody) for the first 12 permanent teeth was apparently identical!

With respect to the skin and its appendages, the similarities of *T* and *C* are so thoroughgoing that no significant difference could be discovered. Eye color, hair color, hair structure (based on microscopic determination of diameters, cuticle, medulla, and disposition of pigment), palm and finger prints, all show a truly remarkable degree of likeness.

In visual functions, however, *T* is somewhat superior. Her focussing is slightly more accurate, her fusion better, her oculomotor abduction and adduction better. In hearing, the twins are virtually equal, with only a slight normal loss in each ear.

The health histories of the twins are very similar. They usually shared all illnesses, such as upper respiratory infection, measles, chicken pox, colds, influenza. One attack of otitis media and pyelitis was confined to *C*. Hypertrophied tonsils, followed by tonsillectomy were confined to *T*. In general, *T* has shown greater susceptibility to upper respiratory infection and slower convalescence after infection. But even under the stress of a grave illness in infancy, they weighed alike to a gram, on two occasions. During the two weeks' period of their hospitalization their weight curves rose and fell and interwove with such close correspondence that they actually crossed at five points. This testified to substantial substratum of somatic identity.

B. MOTOR BEHAVIOR

Both in the execution of patterned movement and in general motor demeanor there is a consistent difference mostly in favor of Twin *T*. This difference is detectible by acute observation and by minute time-space measurements. *T* has been posturally more alert since infancy.

Twin *T* was born a half hour after Twin *C* and immediately after birth she was, by the hospital record, "very active." As a baby her bodily activity was slightly more advanced and more tonic. In tap dancing she moves more vigorously and terminates her terpsichorean pattern with more finish and completeness. Motorwise she tends to be more tense as well as alert and more prone to "nervous" overflow. Her manoeuvres in manipulation in infancy were faster; her pick-up prompter. She still is quicker on the trigger and leaves *C* behind in a 50-yard dash. She also places pellets in the bottle with more dispatch.

The pellet test makes demands upon motor drive and speed. In general, however, *C* is superior to *T* in fine motor coördination. She shows more interest and skill in precise manual tasks. She manages a pair of small forceps with more delicacy; she holds pencil and pen better; she is more adept at crochet work.

C is unquestionably more relaxed, more bidextrous, and more given to symmetry of poise and attitude. *T* displays a more pronounced functional asymmetry: she cocks her head to the left when she writes, she tilts her paper and she slants her letters. *C* confronts her paper more squarely, holds her head straight, and writes more nearly vertically. She shows less emphatic unilaterality both in hands and feet. *T*'s unilaterality is better defined and, ontogenetically, was established earlier. These motor disparities are perhaps the most objective and pervasive which our study has revealed. They have developmental as well as dynamic significance.

C. Adaptive Behavior

No marked difference is discernible in rate of mental development as reflected by the *DQ*'s and *IQ*'s assigned at 22 advancing ages. *T* has a slight edge on *C* in intellectual abilities, when comparisons are made on the basis of speed of performance, concentratedness of attention to focal stimuli in problem situations, interest in things versus persons, repeating digits backward, ball-and-field tracings, scholastic achievement, reading of single words, intentness, and drive in constructive tests.

But both in the aggregate and individually these differences, though consistent, are slight. They are partly offset by equally consistent superiorities on the part of *C*, when comparison is made on the basis of pencil tracings of simple paths, supplying detail and elaboration in drawings of a man, of a house, and of the incomplete man; in utilization of colors; interest in persons versus things; digit recall; recall of reading memories.

There is also a distinguishable difference in the style or deployment of adaptive attention, whether in problem-solving situations or in spontaneous constructive activity. *T*'s attentional fixations are more discrete, *C*'s more far flung; *T*'s transitions are more clear cut, *C*'s more confluent. All told the difference in "style" of mentation seems greater and also more significant than the difference in fundamental calibre.

D. Language Behavior

As a baby *C* was more vocal. As a child she is more articulate, at least more talkative. This appears to be a valid distinction, for it has been consistently maintained from the age of 16 weeks to date. Even after *T* had had the benefit of an intensive course of vocabulary training (84 weeks to 89 weeks), the utterances of *C* were greater in amount, volume, and vigor. In pronunciation, however, *T* is slightly better than *C*, and her vocabulary is slightly larger. But *C* takes the lead both in writing letters and in starting off conversations. She is more communicative. On occasion *T* has talked more because she had more questions to ask. In language comprehension the twins are highly similar.

The ascertainable differences in overt language behavior are bound up with differences in social behavior which will be presently summarized.

E. Personal-Social Behavior

In adaptivity *T* is slightly superior to *C*. In sociability the tables are reversed. *C* is even more consistently superior. As an infant she displayed more social interest in her co-twin than the co-twin (*T*) displayed in her (*C*). Almost inveterately *C* paid more attention to the adult examiner than did *T*. As a child *C* has shown somewhat more interest in her playmates and also in a baby sister, eight and a half years younger. *C* now shows a bit more interest in the opposite sex. She has been somewhat more popular with her schoolmates, both boys and girls; she is less sensitive than is *T* as to what they may do or think. *C* is relatively less aggressive in social situations, less inhibited, more expressive; also more given to teasing. *T* spends more time in reading and probably less time in socialized or personalized phantasy.

In imagining the future, *T* wishes to be a teacher. So does *C*. That is first choice. But on second and third choices their ways part; *T* wishes to be a storekeeper or nurse; *C*, princess or singer. These choices are characteristic of observed differences in personality manifestations.

Some minor differences and preferences may be considered relatively adventitious. Not so the difference in hierarchy which has been present since infancy. Even in a single pair of twins the sociological principle of hierarchy comes to expression. *C* has been the dominant twin throughout most of their career. But the dominance has been slight; and becomes apparent only after a long range review of the data. The fact that the dominance has been so slight testifies to a high degree of counterpoise and identity in the twins even in the complicated sphere of personal-social behavior.

So numerous are the similarities of behavior pattern whenever cross-section comparisons are made so numerous are the correspondences when these cross-sections are viewed in their genetic sequence, that we can read new meaning into Shakespeare's metaphor:

> "The apple cleft in two is not more twin than these two creatures."

Like the apple, *T* and *C* were born of a single seed. And this fact must be the point of departure for any biogenetic interpretation of their manifold likenesses,—and possibly even their differences.

F. Co-twin Control as a Comparative Method

Before proceeding to the task of interpretation, a further word is in order concerning the value and validity of co-twin control as a comparative method. A brief statement of the philosophy of the method may serve to define the cogency of any conclusions which may be drawn.

"*A description of one individual without reference to others may be a piece of literature, a biography, or a novel. But science, No!*" So says M. Meyer. We escape this stricture because we have undertaken to describe one individual with reference to another,—*T* in terms of *C*. We might even claim an extra measure of science in this approach, because we have used for our control a standard of measurement which is at once quantitative and organismic. Statistical norms and devices can never be organismic because they are either heterogeneously unselected or homogeneously selective and must therefore remain analytic and partial in application. But a co-twin control is by definition highly identical with the individual under investigation. He is in a sense the sum of a statistically numerous multitude of forces. He is an embodied quantity who with respect to any distinguishable trait is more or less than the investigated individual.

A control co-twin is a synthetic standard of comparison with a highly equivalent prenatal and postnatal life career, except for divergences which are experimentally created or naturalistically observed. When one contemplates the almost infinite number of variables which enter into the shaping of any life career, it must be granted that an "identical" co-twin who brings these variables into finite and manageable range is indeed an extraordinarily powerful statistic in his own integral person. His individuality is unique, but by definition it is almost a replica of the individuality which is being assayed. The patterns of twin and co-twin do not exactly superimpose. But by matching we measure. We expose areas and directions of discrepancy. The almost complete identity of the datum and the measuring device gives augmented biometric significance to all discrepancies which can be defined and accounted for.

The method of co-twin control has its limitations. A twin is not *an absolute unit of measurement; and we must start all over again* with the next pair of twins. In this sense, twins are uncalibrated and fall outside the calculus of classic mensuration. But when one reflects that even Physics with its beautiful mathematical precisions is never on absolutely absolute ground, we may accord a certain pragmatic value to a method which applies a norm that equals in complexity the phenomena to which the norm is applied.

The *method of co-twin control therefore is suitable for the clarification* of biological data. In the end we come to a better understanding not only of one individual but of two, for one twin reciprocally elucidates the other. When the comparisons are made successively over a long ontogenetic range, this comparative method also illumines the processes of growth. Differences and correspondences in timing establish points to reckon by. And even though the method *is one of dead reckoning and lacks the elegance of classic science, it* may bring a mariner shrouded in shifting fogs to the vicinity of a port!

VIII. BIOGENETIC INTERPRETATION

In the almost parallel life careers of *T* and *C*, documented by systematic observations, experiments, measurements, and cinephotographs we have before us an unusually rich array of data for etiological analysis. Difficult questions of origin and genesis arise. Whence came the multi-farious likenesses? How were they achieved? Why have they been so stable and synchronous? Whence the differences? Why have they been stable, too? Where and how were they established? And if these questions do not suffice we may speculate whether the likenesses and differences will project themselves into adult years. *T* and *C* are already preadults. Was their adolescence prefigured in their infancy?

For the purposes of discussion we shall assume that the similarities and the disparities just summarized are valid. They are supported by objective evidence and by the concurrent clinical judgment of several observers who have worked both with the data and the twins. In a small number of instances the records of a single session of observation apparently contradict the comparisons we have arrived at. For example, on occasion Twin *C* was reported to have been more active than *T*, or less talkative; once or twice *C* even seemed less sociable. These scattered exceptions have in fact helped to prove the rule. In nearly every instance there were qualifying circumstances, or the traits in question were not fully in ontogenetic phase. Preliminary consideration should be given to this question of ontogenetic timing—the tempo of the life cycle.

A. ONTOGENETIC TIMING

If the twins were perfectly identical with respect to both instrinsic and extrinsic growth factors, we should always find them completely in phase. Nevertheless it is possible that even with highly similar twins there is some reciprocal fluctuation in the expression of certain behavior traits during a month, a day, or even an hour. This would throw their two behavior pictures slightly out of alignment and introduce dashes of paradox. Fluctuations in mood swing are not always in perfect phase in twins and that also would introduce transient discrepancies, contrary to general trend. Such temporary divergences are confusing only for brief periods, if the rate of ontogenesis is essentially the same. Over the long reach of 14 years the behavior patterns of T and C were revealed in true perspective; and displayed a durable characteristicness.

We have noted a small but consistent degree of relative motor acceleration in T. This conferred a slightly greater maturity on T which could impress itself on the behavior picture in a manner to exaggerate her superiority over her co-twin. The twins might actually be more identical than they seemed, because a difference in maturity phase alters the manifestation of certain traits. Assume that a given trait "X" changes in frequency or intensity with age. Let the trait be represented diagrammatically (Figure 15) by the developmental curves T and C. If T is more mature than C, the curves are never in full phase. There will be a period between Ages a and b when Trait X will be more marked (or more deficient) in T than C, although essentially they may possess the trait to the same degree. If T possesses the trait to a definitely greater degree, certain fictitious inconsistencies might appear at certain age sectors, due to phase discrepancies in the growth curves. Whether every physical and functional character of the organism carries in its structural basis its own timing mechanism is not known. Time genes have been posited as the determiners of time relationships during the period of embryogenesis.

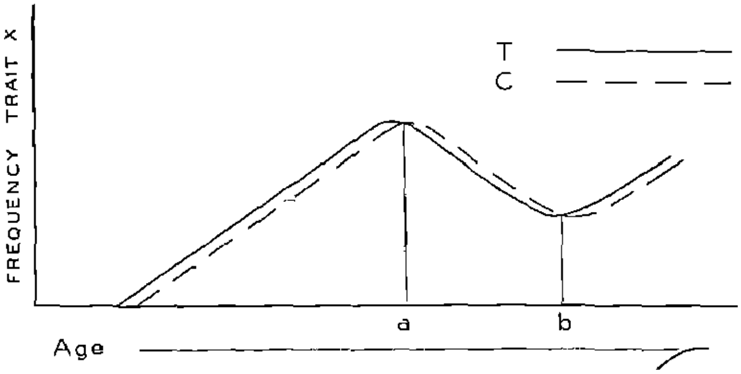

FIGURE 15

Diagrammatic Representation of the Effect of a Hypothetical Maturity Discrepancy on the Frequency of Trait X

Whatever the mechanism, these time regulators were to a remarkable degree alike in *T* and *C*. As embryos the twins were simultaneously derived from a single zygote, which divided with such extreme precision that the basic determiners of temporal schedule were apportioned so evenly in the form of gene effects that the twins have followed almost identical time tables, postnatally and doubtless also prenatally.

The acceleration of *T* has been so slight and so restricted as to have little perceptible effect. To be sure her menarche came six weeks earlier. This is a palpable portion of time; but it is less than one per cent of all the weeks which transpired after conception. Mathematically speaking, this means a high degree of correspondence in two such highly intricate systems as the sexual cycle.

The slight degree of precocity in postural behavior noted in infancy made Infant *T* seem more active, more rangy, more sure on her feet; but this was only for brief periods. *C* was never really outdistanced because she was only a short lap behind and was being pushed forward by almost the same rate of maturing. In the field of fine motor coördination a difference was scarcely noticeable. At 40 weeks of age, for example, both raked at the pellet. At 42 weeks raking was replaced by poking. Both twins placed the extended index precisely on the pellet; both twins flexed the index independently; both twins suppressed thumb opposition at this particular age. Such exquisite chronological correspondence in a very transient pattern of neuromotor immaturity bespeaks a fundamental parity in the vast complex of timing factors which govern ontogenesis. Nevertheless, we believe that the very rarity of complete symmetry in all living structures resulted in the case of *T* and *C* in a slight inequality in the germinal allocation of growth determiners. Ontogenetically this inequality now shows itself in a modicum of relative acceleration in infancy and adolescence. It may well assert itself again in senescence—but only in slight degree, for the inequality is biometrically almost infinitesimal.

B. Physiological Tempo

For convenience we draw a distinction between physiological or dynamic tempo and ontogenetic or developmental timing. Fundamentally the two are controlled by a common biochemistry, for ontogenesis is simply the most complicated of all physiological processes; it is the physiology of development.

The most readily measurable manifestation of physiologic time in the narrower sense is speed of movement, that is the capacity to mobilize, to release, and to shift quantums of available energy. It takes time because it depends on body chemistry. It takes *C* more time than *T*; and thereby hangs a very fundamental difference.

What is the source of this difference? It probably is not motive in the ordinary sense, a desire to excel, or a reaction to inferiority, for it was displayed by *T* in early infancy. It is unmistakably written into the time records of the cinema. It persists to this day in acts of motor execution, whether legs, feet, hands, fingers, or eyes. *T* is more highly geared. She was more lively as a neonate. She probably was more lively as a fetus. Possibly the same chemico-morphogenetic events which made her the accelerated twin made her also the speedier one. But this slightly greater patrimony has not borne interest. *T* has accumulated no greater gain because of her head start, for *C* has her own speed regulators; and they are after all very much like *T*'s.

It may be suggested that *C* has a slightly different endocrine constitution, which relatively speaking retards her metabolism and thus slows down her reactions. But this would be a correlated rather than a primary causative factor. Moreover, metabolism is too broad a blanket-term to be very useful in the comparison of two individuals who are as similar as the proverbial two peas in the selfsame pod. Metabolisms are varied; they differ specifically for different tissues and organs; they are in a sense as distinctive as are patterns of behavior.

While the chemical reactions which underlie voluntary movement are apparently more rapid or intense in Twin *T*, there are other spheres of body chemistry in which Twin *C* is "faster." Usually she recovers more rapidly than her co-twin from the effects of a simultaneous and presumably equally severe infection, at least in the upper respiratory tract. This denotes a difference in immunological mechanisms which are of course chemical. Twin *C* is less sensitized than *T* to certain toxins. The humoral and homeostatic differences, however, cannot be considered great. The twins have had very similar health and morbidity histories. Indeed, the most dramatic demonstration of their likeness in chemical constitution was their well nigh identical response to the threat of an almost lethal toxemia.

In search for "causal" explanation, one might attribute the greater motor intensity and vividness of Twin *T* to a stronger drive. But from the standpoint of an etiological chemistry, the term drive is sterile. Drive, so called, is if anything a consequence rather than a source of greater speed and intensity. It depends on autocatalysis. The concept of tonicity is perhaps more illuminating. *T* has consistently shown greater tonicity than her co-twin. This points to an intrinsic difference in neurological constitution. Muscle tone has its primary source in the central nervous system. It consists of proprioceptive reflexes whose early development traces back to the fetal period. In the absence of any illness, injury, or nutritional factor it seems logical to ascribe the greater speed and energy of *T*'s motor behavior to neuromotor constitution.

Her greater efficiency in executing complete and coördinated movements (in dancing and to some extent in writing) may be reinforced by cultural factors. She is more sensitive to praise and blame; she has more zeal to succeed. But here again more primitive constitutional factors count, among them the important factor of functional asymmetry.

The motor organization of *T* shows a more pronounced unilaterality: She is more decisively right handed. This laterality was acquired through organic maturation, and is in no sense a product of culture. It makes a better machine for the initiation and control of voluntary movement, than the more neutral motor equilibrium of *C*. The motor organization of *C* is both more symmetric and less tonic. By this reasoning the more quiet poise and easier attitudes of *C* are not a product of acculturation. But her motor characteristics are not without cultural consequences.

We soon reach a point in our analysis where postural sets and motor skills take on psychic as well as mechanical meanings. For example we were impressed with the fact that *C* at the age of six years was more executive and deft in her very maternal doll play than was *T*. In motor skill *T* is generally superior; and at six years she was more adept in tying a bow knot. But significantly enough she was more awkward in her handling and fondling of a doll. An emotional difference entered into this discrepancy.

In matters of neatness and tidiness we again have to reckon with a mixture of cultural and native motor determinants. *C* is "by nature" somewhat less tidy. *T*'s interest in form leads her to more tidiness in the disposal and manipulation of materials even when social compunctions do not operate. The phrase "by nature" partly begs the question. But it also suggests that *C*'s motor disposition, combined with her slightly more relaxed emotional and more lackadaisical motor attitudes, *makes her naturally more tolerant of disorder.*

It is well to insist that maturation and acculturation do not function in separate compartments. Nor do motor and personal-social traits organize either separately or by way of mere supplementation. They interact, possibly even interfuse; but never independently of the original gene effects. With respect to the very fundamental character of physiological timing, as expressed in speed, decision, and tonicity of movement, *T* was endowed (through the gene effects) with slightly superior potentiality.

C. ATTENTIONAL HABITUDES

Further differences and similarities in our twins may be considered in terms of attentional characteristics. The concept of attention needs no redefinition here. We shall use the word in a broad psychobiological sense as equivalent to the selective orientations whereby the organism adapts to environmental situations. Do *T* and *C* differ in any fundamental way in these selective, orientational trends? Habitude includes all deep seated dispositions whether native or acquired.

To some extent we have already answered our question; because attentional characteristics are inseparably bound up with motor demeanors and postural set. If motorwise, *T* is more tonic, more restless, more active, more abrupt in bodily and mimetic movements, it is possible that the movements of her mind, which are called attention, share some of these qualities. By motor tokens, *C* is more tranquil, more composed, more equable, less flurried. If we could see the hidden patterns of her attention we might find it partaking of similar qualities. Compare the twins sitting side by side, while each is writing a letter with pen and ink, to Mrs. H. Twin *T* adjusts her hair repeatedly, inspects her pen repeatedly, blots her writing perhaps twice as often as *C*. She blots it with a tattoo daub. *C* blots smoothly with a soft, horizontal rub. These are motor idioms; they doubtless also reflect attentional and affective idioms. The typical emotional coloring of *C*'s mental processes appears to be softer and warmer than that of *T*,—more often suffused with personal and social reference. As infant, preschool child, and school child *C* has shown a greater interest in persons. She has been more of a home body. *T* has shown a little more tendency to go beyond home bounds. This difference, slight in degree but pervasive and persistent over the years, denotes a genuine distinction in oriental trends,—a difference in attentional habitude.

As a corollary of this we may say that *C* is on the whole more conservative than *T*. *T* tends to over-react whereas *C* has more emotional and intellectual poise. *C* is steadier. In a complex situation she does not react as quickly as *T*; she is slower witted (to a slight degree), but more likely to be right in the end. Mood swings are wider and more frequent in *T* than *C*. In the Kent-Rosanoff test *T*'s responses were more usual; *C*'s more unusual; but on the Rorschach test, *T* gave more detailed responses; *C* gave whole responses. The latter difference is consistent with greater conservatism.

Differences in attentional habitude are revealed both in impersonal problem-solving situations and in social situations (Table 48). If we list the observed differences in parallel columns we note that the characteristics peculiar to each twin are naturally correlated. They seem to "hang together" and they "hold up" under many circumstances. They may be construed as symptoms of a slight but genuine disparity in otherwise almost identical psychic constitutions.

TABLE 48

ATTENTIONAL CHARACTERISTICS

T	*C*
Prompt initial pick up	More deliberate initial pick up
Intense fixation	More relaxed fixation
Sharp focalization	More diffuse focalization
Decisive	Roving
Discrete	Confluent
Delimited	More sensitive to context and margins
Selective for details	More comprehensive and extensive
More varied adaptive exploitation	More imaginative personal-social elaboration
Specifically alert	More generally alert
Less initiative in social situations	More initiative in social situations

The foregoing differences do not always come to clear cut expression but they are not subject to fortuitous circumstance, or to whimsical chance. In her thinking, play, and phantasy *C* tends to stay nearer to home base, that is to a point of origin; and she tends more strongly to come back to her moorings. Generally speaking her mental transitions are more confluent, less disjunctive. This difference, however, small in magnitude, represents a distinction in modality of attention,—a difference in attentional habitude.

Certain dynamic differences in the twins are so deep seated that they come into view, whatever category may be applied, whether motor, physiological, or attentional. If we used still other categories such as "temperament," "extroversion," "integration," "life-space," etc., the same differences would again declare themselves. This fact betrays the fluidity of present day psychological concepts, but it also suggests the unity of underlying personality, and the validity of the individual differences which are under discussion.

D. PERSONALITY

Among all available concepts, that of personality is omnipotent. It is *not indispensible*, because we could subsume all of our observations under the three categories which have already been presented. By personality we mean the pervasive superpattern which expresses the integrity and the characteristic behavioral individuality of the organism. Or in Allport's formulation, "Personality is the dynamic organization within the individual of those psycho-physical systems that determine his unique adjustments to his environment."

Fortunately we have limited ourselves to a comparison of Twins *T* and *C*, and fortunately they are much alike. Otherwise we could hardly venture into the intricate terraine known as personality! Even so, there are in *T* and *C* considerable areas of phantasy and emotional life which we have been unable to explore. We shall not attempt to state in what way *T* and *C* as individuals are unique when compared with the rest of humanity, but by narrowing our trail, we are able to identify a few stable differentiae which are unique for *T* when she is compared with *C*. That similar differentiae in yet greater degree obtain throughout the whole human family can scarcely be doubted.

T is unique by virtue of certain characteristics in ontogenetic timing, physiological tempo and attentional habitudes,—which characteristics are combined or organized into a distinctive individuality. Similar, and yet subtly unlike characteristics, combine in *C* to make another distinctive individuality,—a pervasive super-pattern.

It is significant that the uniqueness of *T* could be explored and established only by systematic comparisons and by genetic studies. If the twins in their parallel careers had shown contradictory and paradoxical characteristics frequently rather than occasionally, we should not now be able to affirm that *T*'s personality is unique when compared with *C*'s. During the first year of life we were not clear whether certain observed differences in behavior should be set down as mere differences in abilities or should be construed in terms of personality or temperament.

Making due allowance for differences in maturation entirely due to ontogenetic timing factors, we find differences in modes or styles of behavior as well as in sheer competences. Such modes or styles probably inhere in personality. They are symptoms of personality make-up.

A divergence in "style" showed itself most transparently in the field of drawing. This does not mean that the divergence was in any way peculiar to drawing. Drawing is a cultural activity highly subject to the leveling influence of imitation and doubly so in twins because twinship is a little cultural eddy in the main stream of culture; and all forces conspire to make the drawing behavior of one-egg twins alike.

In spite of this conspiracy, *T* has displayed a consistent tendency toward "straight linedness" and *C* an equally consistent tendency toward curvedness. Typical of these divergent trends are the following differences registered in their drawings:

T tends to make a solid circle button.
C tends to make an open circle button.

T, straight mouth.
C, a curved mouth.

T attaches a straight string to her balloon.
C attaches a curving string to her balloon.

T hangs oblique curtains in her house.
C hangs flounced curtains in her house.

T attaches a straight pull cord to her curtain.
C attaches a curved pull cord to her curtain.

T's chimney emits streaming smoke.
C's chimney emits curling smoke.

T's deviations in a traced pathway are angular.
C's deviations in a traced pathway are curved.

In posture, gait and dancing similar contrastive tendencies in angularity and curvedness display themselves.

Here are style differences which we have captured, simply because the drawings of children so faithfully reveal their inner urges and constitution. If we had similar objective records in more elusive fields of behavior, we should probably find the same kind of differentiations. It would be especially instructive if comparable registrations of emotional habitudes were available.[4]

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[4] We catch a glimpse of the actuality of such registrations in written composition as well as in spontaneous speech. After the present manuscript had gone to press, Twins *T* and *C* simultaneously graduated from Grammar School. A few days after graduation we gave them this commission: "*Please write a story for us—about anything you please.*" The twins immediately wrote their stories, entirely independently, without any intercommunication. The stories follow. Let the reader decide who wrote Story *A*; who wrote Story *B*!

Story A: "*Our Graduation Program*"

> To start the program we lined up in the hall and marched up to the assembly onto the stage. *Waltz of the Flowers* was sung by the eighth grade, after the song we sat down on the stage and a speech was given by *B.R.*, and another by *P.D.* Another song was sung by the eighth grade, *Wild Rose*, and two more speeches were given. *The Anvil Song* was sung with the base and eighth grade, and two more speeches. *Mah Linde Lou* was sung and two more speeches. Mr. S., the chairman of the school board, gave out the diplomas and another song was sung and we marched back down to our room and changed our diplomas.

Story B: "*My Story*"

> This story is about graduation. I never had so much fun in all my life, but just think I will be entering high school in the fall.
>
> The Friday before we graduated Mr. F. took the class in the hall and told us we were going to march upstairs for graduation. We did have fun, many children couldn't keep in step. We marched with a victrola and that was fun, because the record in some places would go fast and in other places would go slow.
>
> On Monday he took us out in the hall again and said we would practice marching upstairs, and that was fun because we would have to walk like babies up the stairs.
>
> On Tuesday we practiced marching on the stage and taking our seats.
>
> On Wednesday we practiced getting our diplomas, and that

Emotions probably have pattern and configuration almost in the same sense that motor reactions have pattern; though we tacitly beg the question if we carelessly imply that emotions can be completely detached from the motor expressions of behavior. Motor reactions are movements in Newtonian time-space. They are quick or slow, angular or graceful, atactic or confluent; crescendo or diminuendo. To a certain extent they can be described in terms of musical notation. Emotions are perhaps deployed in a non-Newtonian time-space, but analogically they can also be described by the devices of musical notation. Speculatively it is our impression that the emotional life of *T* as compared with *C* shows differences which are comparable to those exhibited in visible motor deportment. *T* is more intense, possibly even more sensitive; her emotional reactions are more crisply defined. *C*'s are more equable and confluent, less sharply configured; more catholic, more benevolent, less critical.

To elaborate these conjectured differences would take the pen of a novelist. Even though they cannot be objectively established, we have at least suggested that emotional complexions, affective habitudes, and characteristic dispositions do not necessarily owe their origin to experiential events; that they may be laid down by those earlier and profounder biogenetic events which primarily determine psychic-constitution.

E. ORIGINS OF INDIVIDUALITY

It is now definitely known that twins as similar as *T* and *C* are derived from a single zygote. This zygote in an early stage of bilateral doubling underwent more than the ordinary degree of cleavage and instead of a singleton, two individuals were derived from one selfsame ovum. As already suggested the remarkable resemblances and identities in Twins *T* and *C* may be ascribed to the very accurate halving of the original genetic substances. So nice was this partition that two almost interchangeable individuals were the result, not only *in utero* but also throughout the whole postnatal period from birth to adolescence.

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was fun because we would have to take our diploma in our left hand and shake hands with our right.

On Wednesday night we graduated and that was the most fun of all.

Perfect precision, however, is not the rule even in nature. No apple was ever cleft exactly in two. There were slight deviations in the mechanisms of symmetric regulation which must have imposed at least subtle differences in the genetic constitution of *T* as compared with *C*. Our interpretive problem is to inquire to what extent the observed and demonstrated differences in the characteristics of *T* and *C* must be ascribed to these earliest divergences in the process of twinning when the genetic constitution of both individuals was laid down. If similarities must be ascribed to identities in genetic endowment, there is no logical reason why disparities should not be ascribed to comparable factors. But for purposes of analysis we must rule out as far as possible all extrinsic and environmental sources of differentiation.

To begin with we may ask, *Were the twins more alike in early infancy than they are now?* They were perhaps less easily distinguished. It was more difficult to detect and to describe their slight differences in behavior. Small but significant differences remain relatively obscure in infancy because we lack the acumen and technology to identify them. With age, as the whole complex of behavior patterns elaborates, the evidence of small differences becomes more obvious. The original differences have not actually increased in magnitude; they have simply spread or diversified their manifestation. From a purely quantitative standpoint therefore we are not permitted to say that Twins *T* and *C* were much more alike in infancy than they are in their adolescence.

Brief notes made when they were six weeks of age record our impression that *C* was more placid than *T* and less tense. *T* was more reactive to objects than *C*. Retrospectively these few items now have prophetic implications. At eight weeks likewise *T* was more alert in fixating objects. She was more active in the prone position. At the age of 28 weeks when we decided to make the twins the subjects of special study, the records are fuller and the data become more solid. In addition to dictated accounts of their behavior under developmental examination, we have cinema records which were subjected to careful analysis (by L.B.A.). At 28 weeks on the joint evidence of cinema and examination records, we find that *T* is more active posturally; that *C* is more bidextrous; that *T* is quicker to respond to the motor test situations; that her movements are speedier; and that *C* is more responsive in social situations. *C* vocalizes more and in a more varied manner than *T*. Computation of time values recorded in the films demonstrated that *C* spent more time looking at the Examiner than did *T*. *C* spent more time looking at her co-twin than did *T*. *T*'s attention was more decisively directed to the stimulus objects and more focalized in character.

To a considerable extent these are the very differentiae which subsequently were verified over and over again by tests and measurements and by cinematic comparisons. In spite of occasional reversals, the differences noted at 28 weeks have proved to be durable.

Why have they been so durable? Partly because there have been no genetic or psycho-genetic events which have been powerful enough to conceal or to destroy these deep seated characteristics. Over the long reach of 14 years the twins have had very similar environments. They have been under the same roof and the same skies; have eaten from the same board, enjoyed the same excursions, worn similar clothes, possessed almost identical belongings. And they have always had each other.

Psychologically they have never been separated. Their physical separations have been brief and mild. For the most part they have had the same illnesses. In bodily strength they have been much alike and the intertwin dominance has never been extreme or harsh. This virtually constant and evenly balanced companionship has operated like the two balls on the governor of an engine. It has served to keep both twins in their orbits and to stabilize their characteristics.

Allowing for the moment a somewhat naïve distinction between environment and endowment, we may generalize the issue by saying that the environments (physical and personal) have been sufficiently alike for *T* and *C* to perpetuate original identities and small differences in individuality.

But we are chiefly interested in the origins of individuality. Have there been in the life careers of *T* and *C* any exceptional environmental factors sufficiently powerful to initiate and to create basic individual differences?

We know of no such factors, nutritional, biochemical, or meterological which could have differentiated their somatic constitutions. Educationally they have had somewhat different experiences, but equal opportunities, and in their school progress they have been abreast. They attended kindergarten together and always went to the same school building. They were in separate schoolrooms in the first, second, third, and fourth grades. For four years one twin had a youngish teacher, and the other a somber, oldish teacher who regarded tardiness as a misdemeanor serious enough to warrant strapping. Day in and day out one twin was subjected to a different school climate. This was in effect an unplanned experiment in differential training. There is no evidence that this created any permanent psychological deviation to the advantage or disadvantage of either twin.

Twin *T* has been subjected to hundreds of hours of preferred and specialized training designed to improve her motor coördinations, her neatness, her constructiveness, her span of attention, her vocabulary,—a considerable variety of behavior attainments which have been recounted. There is no evidence that all these systematized experiences added either a cubit to her mental stature or a basic component to her individuality. She doubtless profited in some measure by the experiences. They may have facilitated certain motor and social adjustments; but they have conferred no substantial, demonstrable addition to her original equipment. We should like to think that her present prowess in the 50-yard dash is in some lawful manner the full flower of her systematic training in stair climbing at the tender age of 46 weeks; but we cannot make the claim.

The equalizing influence of their own mutual companionship has already been stressed. It has operated to inflect remarkable similarities even in the outward configurational details of their personal-social behavior. But were there no forces or events in the deeper levels of love attachment and of parent-child relationship which created a basic difference in psychological individuality? Were there any forces which worked traumatically or by subtle attrition? From the standpoint of psycho-dynamics the relationship of the twins to their mother must be considered of capital importance. In maternal affection we are dealing with elemental Promethian fire. The mother, on her own testimony, has shown more affection for *C* than for *T*. Is this, then a genuine psycho-genic factor which accounts for the greater sociality of *C* and for other associated colorings in the complexion of her emotional life? It might be reckoned as a genuine psycho-genic factor were it not for the fact that the mother (it was a stepmother) loved *C* appreciably more because *C* by virtue of her own nature possessed a greater fund of sociality.

C's amiability attracted a greater portion of the affection which the mother gave to both twins. Thus once more, endowment proves its *priority* over environment,—when we make a distinction for purposes of analysis. The greater maternal affection enjoyed by *C* did not *initiate* a greater degree of sociality in *C*. *Indeed*, this greater degree of sociality in *C* was evident in the twins throughout their infancy. They did not come under the care of their stepmother *until the age of two years*.

The very etymology of the word amiability (ami-*ability*) serves to remind us of the interacting mechanism between endowment and environment. *C* had a tithe more of the quality or state of being lov*able* and this deflected the "environment." It was not the environment, per se, which created the quality or the state.

This interpretation must not, of course, be overgeneralized. It seems to apply in the present instance and emphasizes the interdependence of personal and of social factors. In last analysis, however, the organism plays the *primary rôle in determining environment*. And the area of primary determination is equivalent to basic individuality. When human behavior is organized in a cultural milieu, there is almost an infinitude of available environments; the organism selects from this infinitude in much the same way that a living cell may or may not select potassium from a fluid medium. The structure of the organism, whether conceived in terms of biophysical waves or particles of stereo-chemistry, is attuned to what it selects and averse to what it rejects. For this reason it has proved difficult to find pure, thoroughgoing psycho-genic factors to explain the individual differences in the life careers of *T* and *C*.

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ADDENDUM

In addition to the foregoing references mention should be made of two edited 16 mm. motion picture reels which deal respectively with (*a*) *Similarities of Behavior in Twins T and C*, (*b*) *Dissimilarities of Behavior in Twins T and C.* Each reel is 400 feet in length. It is planned to make these reels available for instructional purposes and for individual study as a supplement to the present monograph.

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FINGER NAIL-BITING: ITS INCIPIENCY, INCIDENCE, AND AMELIORATION*[1]

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I. THE PROBLEM AND ITS SCOPE

A. The Problem

In conducting this study of nail-biting, the major issues investigated were the probable causes, the conditions under which it occurs, and what might be done to alleviate it. These, considered as a whole, are the problem. Smaller segments had to be isolated to handle effectively such an inclusive venture.

B. Delimitations

The limitations of the study are obviously those of the subjects; and the particular set-up which was incorporated in gathering the data.

The very nature of nail-biting, as it occurs in the social scene, necessitates the omission of many desirable laboratory controls. If we were to attempt their application we undoubtedly would, unknowingly, give the subjects cues as to what was expected of them. This would establish a "set" which would invalidate the data. The subjects would tend to do what was expected of them; or, in a few cases, they might be negativistic and behave accordingly. A large part of the sub-problems which follow had to be so posited as to eliminate the need of obvious, extraneous controls.

All the subjects utilized were studied in the school situation, during regular class periods, with the exception of a few cases which were from the children's ward of the Allentown State Hospital. Since the activities which take place in schools are to a large measure prescribed and formalized this might be considered, in a measure, as a form of control. Most activities are reduced to a rather stereotyped routine.

The specific controls utilized in the various sections will be stated at their proper places.

C. Need of the Study

In considering the need of investigating finger nail-biting, it was found that others have stated their desire to see this problem studied in a more comprehensive manner (54, 56). Allport, Jersild, Garrett, Hurlock, Symonds, Walker, and Bernreuter, in interviews with the writer, indicated an interest in seeing further investigation take place and offered useful suggestions which have been incorporated where feasible.

In 1931, during his first year of teaching, the writer first became aware of the prevalence of nail-biting, and of the difficulty of curbing this behavior. Each succeeding year, as the study progressed, its importance became more conspicuous. Probably the most revealing fact is that during the academic year of 1939-40 approximately 66 per cent of the students investigated were at the time being, or had at some time of their life, engaged in nail-biting activity.

The absence of an adequate analysis of nail-biting has led the author to conduct this investigation in order to fill, in part at least, this apparent gap.

II. HISTORICAL REVIEW

In reviewing the literature pertaining, directly or indirectly, to nail-biting, it is pathetic to find that those studies which have been conducted are inconclusive and inadequate. The attention which nail-biting has merited is, largely, as it occurs in relationship with various other behaviors; or strictly clinical studies. Olson, the study most cited by various writers in connection with this behavior, is primarily a statistical study (41).

A. Definition

Various terms are used to designate the behavior under consideration. Olson includes nail-biting under the classification of tics (41). Dunlap agrees with this classification by saying:

> Tics; that is, obsessive motor performances such as thumb-sucking, and finger-nail biting, and recurrent movements of an annoying sort, . . .
>
> Finger-nail biting and thumb-sucking are habits which for practical purposes are to be classed with tics, although not generally so designated (16).

Others who are in agreement with this classification follow. Scholz says, "das Nägelkauen gehört zu den Tics" (51). Moll contends nail-biting is a tic, since it occurs mostly in neuropaths (35). Walsh and Foote designate it as a tic by stating, "almost any normal movement may, in nervous children, come to be repeated so frequently as to become a tic" (68). Hoppe finds "a certain degree of mental instability is a distinguishing feature of tic patients (26). Wilson characterizes a tic as "just an involuntary, often unconscious act that serves no legitimate purpose" (73). In discussing tics Kanner says, "tics or habit spasms are sudden, quick, involuntary, and frequently repeated movements of circumscribed groups of muscles, serving no apparent purpose" (29).

Other writers consider the term "habit" or "habit spasm" as appropriate. Cameron defines this type of behavior with the following statement: "by habit spasm is meant the constant repetition of an action which was originally designed to produce some definite result, but which has become involuntary, habitual, and separated from its original meaning" (11). Healy, *et al.*, consider it an undesirable habit (24). Bentley goes one step further and calls it a loathesome habit (6). According to Richmond it is "one of the persistent infantile habits" (48).

Another definition given for nail-biting is that of Stagner who considers it a nervous gesture (56). Sherman, in discussing this problem, says, "they are probably compulsions, because the individual must perform the acts in spite of his attempts to inhibit them" (55). Terman and Almack consider "nail-biting, chewing pencil, etc.," as "disturbances of motor control" (62). One of the more bizarre definitions is that of Wechsler who considers it "nothing but a particular form of unconscious masturbatory activity" (71). Bagby suggests it occurs as "random incidental activity, if the organized conduct and speech do not permit of adequate release of the energy produced by the tension" (4). He contends nail-biting is a form of diffusion. Rivlin considers it a neurotic trait (49). Crane says "nail-biting may indicate repression, but it can also indicate a normal outlet in a child who is full of energy but simply sitting still" (14).

Each of these various definitions, as can be seen, tend to stress one aspect of this behavior. Writers in each field stress their respective perspective. Elsewhere in this study a systematic point of view will be attempted.

B. Description

Descriptions of nail-biting activities also vary, however, the general contention being that it is part of the neurotic syndrome. The following statements are examples of these variations. Stevens says:

> Nail-biting is perhaps really but an advanced stage of thumb sucking, or rather thumb sucking oral satisfaction elevated to the genital zone. Mother striving probably is served on the pleasure side; whilst in the oral removal of the nail, castration at the hands of father is symbolized. The finger has of course a phallic significance in this auto-erotic rite. With the making of an identification with father, it is natural that nail-biting should cease to have significance to the child (58).

Cramer describes nail-biting as "an exquisitely psychopathic symptom" (13). Homburger considers nail-biting as *"Motorische Spannungsentäusserung"* (25). Kanner claims it "is mostly an expression of tenseness" (29). Murphy, *et al.*, believe it to be "in some way connected with ineffective coöperation" (40). Shaffer, in describing tense behavior, maintains it to be "the manifestation of a continued stimulation arising from a visceral state. . . ." (53). Stagner treats it as "overflow phenomena related to continuing emotional strains" (56). In comparing the behavior of children Thom concludes:

> Nail-biting is more apt to be found as part of the picture in the neurotic child than is thumb-sucking. Many of the thumb-suckers are calm, placid, unemotional children, while the nail-biters are apt to be hyperactive, quick, fidgety, energetic individuals with whom everything seems to register on the nervous system in an exaggerated manner (63).

Griffith and Mitchell have observed it:

> . . . only in decidedly nervous children. It is more significant of a disordered state of the nervous system than is thumb-sucking. It may be done only when the general nervous condition is worse, or when the patient is under some sort of excitement or worry (19).

Guilford and Guilford, in a factor analysis of personality, "showed that there is not a single dimension of hyperactivity-hypoactivity, but probably at least four. Two of them were clearly identified as Factor *N* (nervousness or jumpiness) and Factor *GD* (general drive, characterized chiefly by a pressure toward action)" (20). A synthesis of the items isolated gives us the picture "of a jumpy, nervous, hypertense individual" (20).

The position of Thom seems sound:

> . . . individuals exhibiting definite, isolated bits of conduct which may be extremely annoying to others, often without causing the individual himself much concern or having much effect on his adjustment to life. They include nail-biting, bed-wetting, various antics and mannerisms such as snuffing, blinking the eyes, jerking the neck, and stammering. Such conduct is often but a carry-over of a childish habit which had its origin in a mental conflict over some situation that has long since ceased to be operative. Or instead of being carried over directly from childhood to adolescence, it may be interrupted by a period of months, sometimes years, recurring during adolescence under certain emotional situations having associations reverting back to earlier experiences or under situations having excessive mental stress or physical strain in themselves (64).

C. ETIOLOGY

The following excerpts, from various sources, denote the probable causes of nail-biting. According to Chapin and Royster, some of the more familiar causes are "nervousness on the part of the child, or . . . from imitation" (12). Richards places the emphasis upon strain, which she claims "are, *nine times out of ten, to be found in a little careful scrutiny of situations at home, in school, and on the playground, and of the personalities concerned with these situations*" (47). She contends "no one educational or economic cause is responsible for this paradigm of faulty child behavior" (47). Jeans and Rand say "it usually seems related to some emotional tension" (28). Bentley indicates it develops from simpler forms of nervousness (6). Starch, *et al.*, consider it "to be one of the several pernicious effects of mistakes in discipline of the child from the ages of two to six and early adolescence" (57). Moll discusses the sexual implication:

> . . . certain other childhood habits, such as nail-biting, have also been described as sexual manifestations. . . . It is true that nail-biting and masturbation may both occur in the same child, and French writers have maintained that there is a causal nexus between the two processes. If we regard nail-biting as a "tic" occurring chiefly in neuropaths, and if we assume that the neuropathic congenital predisposition is the basis of the premature awakening of sexuality, it may be supposed that to that extent there exists a relationship between the two phenomena, inasmuch as we may refer both manifestations to a common cause, viz., the neuropathic predisposition. But there is no justification whatever for regarding, as some do, one manifestation as the direct consequence of the other (35).

Olson finds support among the writers to consider it "in some degree indicative of a neuropathic predisposition" (41). Hoppe alludes to the fact that there is always evidence of "mental instability" (26). Anderson believes it "to be an outlet for emotional energy arising from maladjustment from enuresis" (3). Sherman says it is "due to a neurotic condition" (54). Healey, *et al.*, say "there are a number of causes, which vary with different individuals" (24). Morgan in discussing the cause says:

> A child bites his nails almost invariably as the result of nagging. He tries to do one thing, is thwarted and tries to do

> another, is thwarted again, and so on. This leads to the condition of supersensitiveness which the physician is so likely to call neurotic, and nail-biting is merely one symptom of this instability (36).

According to Dunlap:

> This habit is always a symptom of maladjustment, minor or more serious, and the family, social, and personal life of the finger-nail biter should be carefully analyzed. The sources of the maladjustment are extremely diverse, but like the tics, properly so-called, frustration of or inadequate outlet for normal desires are the most frequent causes (16).

Wechsler, taking a psychoanalytic point of view says:

> . . . It may serve as a means of oral erotic gratification, and thus may be looked upon as a continuation of the infantile thumb-sucking habit. This libidinal significance of the act is perhaps most clearly indicated by the type of situation which calls forth the activity in the adult who is not an habitual biter. These situations are almost invariably instances of stress, as *when the individual is under mental stress, worried, absorbed in deep thought, etc. . . . the more common significance of the habit, and the one that explains the biting of the nail as well as the introduction of the finger into the mouth, is that it serves as an onanistic equivalent. . . . Continued fingernail biting is* thus a symptom of an incompletely resolved Œdipus situation (71).

D. OCCURRENCE

That there seems to be little doubt among the writers of this behavior being widespread and persistent is evident from the following quotations. Chapin and Royster have observed that "sometimes whole families of nail-biters are seen" (12). Ward states that from "case records at the Institute for Child Guidance, New York, . . . compared with children of 3-child families, only children showed more restlessness and over-activity, crying, nail-biting, and school difficulties" (69). Blount states, "nail-biting is a real problem even in high schools" (8). Michaels, *et al.,* "five traits (enuresis, thumb-sucking, nail-biting, speech impediments, and temper tantrums) were found to occur more often in combination than in isolation" (34). Comparing normal with problem children Preston and Shepler say, "any of those traits such as nail-biting, thumb-sucking, enuresis, temper tantrums, timidity occurred both among those children who were classed as problems and among the remaining 'average' members of the class" (45). According to Sherman "they occur especially during periods of anxiety, frequently in anticipation of a critical situation" (55). Richards believes "a large majority of children pass through nail-biting at some period of their existence, especially if they have a restless, energetic, and on-the-go kind of temperament" (47). Cameron thinks "that habit spasms and tics of all sorts are made worse by excessive emotional display and nervous fatigue" (11). Kanner says "nail-biting is practiced by numerous children and quite a few adults of all ages and all degrees of intelligence and social status" (30). A French writer says of its occurrence, "in Paris, France, one-third of the school children are subject to this habit" (7). Shaffer states that "in the chronic type of case the nervous response may become habitual and may therefore be continued long after the problems which first elicited it have ceased to exist" (53). Dunlap considers, "finger-nail biting is a vice which characteristically afflicts individuals in adolescence, and may be continued into adult life" (16).

TABLE 1

PERCENTAGE OF INCIDENCE OF FINGER NAIL-BITING FOUND BY VARIOUS INVESTIGATORS (50)

Author	No. and type of cases	Nail-biting per cent
Ackerson	2,853 white boys	12.0
	1,739 " girls	18.0
	245 negro boys	10.0
	163 " girls	6.0
Anderson	22-27 enuretic girls	68.0
	39-63 " boys	41.0
Bowman and Raymond	50 schizophrenia	17.8
Foster and Stebbins	150 pre-school children	6.0
Michaels and Goodman	220 Girls	57.1
	255 Boys	45.7
	475 Total	51.3
Stevens	Hundred College Freshman	31.0
	Hundred prison inmates	15.0
Taylor	190 Children	17.4
Tilson	225 pre-school children	6.2
Ward	100 only children	19.0
Wechsler	3,000 pre-school and school children, both sexes	app. 30 (71)

A presentation of the findings of various investigators of the incidence (in per cent) of finger nail-biting is given in Table 1. Wechsler, in his study,

> . . . made observation on some 3,000 children of both sexes, ranging from one to seventeen years in age. The subjects were for the most part children attending the New York public schools, or in the case of the very young ones, of infants at public nurseries. . . .
>
> Examination of the fingers shows: that fingernail biting under the age of three does not occur. . . . The tendency first begins to manifest itself during the fourth year, rises slightly in the next, and then suddenly jumps at age six, from which year it maintains a fairly constant level until puberty . . . the percentage once more rises and continues at a high peak for two years. It then quickly recedes to a very low level, . . . which is probably the per cent at which it continues for the entire adult period. . . . (71).

The incidences found by Wechsler are shown in Tables 2 and 3.

TABLE 2 (71)
Boys

Age	Total number	Number biting	Per cent biting
Under 3 years	31	0	0.0
*3-4	31	1	3.3
*4-5	40	10	20.0
5-6	70	19	27.1
6-7	177	52	29.4
7-8	153	55	35.9
8-9	112	40	35.7
9-10	122	47	38.5
10-11	127	43	33.9
11-12	104	35	33.7
12-13	103	36	35.0
13-14	110	48	43.6
14-15	150	63	42.0
15-16	114	37	32.4
16-17	68	19	27.9
17-18	21	4	19.0

*Boys and girls.

TABLE 3 (71)
GIRLS

Age	Total number	Number biting	Per cent biting
Under 3 years	..	..	....
3-4	..	..	....
4-5	34	7	20.6
5-6	58	18	31.0
6-7	184	57	30.9
7-8	158	63	39.9
8-9	91	23	25.6
9-10	98	33	33.7
10-11	76	25	32.9
11-12	87	38	43.7
12-13	81	36	44.4
13-14	163	56	34.3
14-15	196	61	31.1
15-16	184	44	23.9
16-17	82	13	15.9

E. AMELIORATION

Various methods have been suggested as probable amelioratives. Some of these are in direct contradiction to others. The following are representative suggestions. Wechsler says:

> . . . , all efforts at reducing it, based on the psychology of habit formation must be doomed to failure, and anybody who *has had any experience in the application of such habit breaking* procedures as applications of aloes and taping of fingers knows how useless they are. They are not only useless but injurious because they merely serve to fix or at best to displace the symptom. So also is probably the effect of calling attention to or constant harping on the "habit" and the infliction of punishment on the child for failure to desist, in any form. . . . The only way to treat nail biting, . . . is to attack the cause and not the *symptom itself* (71).

Isaacs, likewise, discredits negative methods:

> I have accumulated a good deal of evidence showing the uselessness of negative methods of dealing with nail-biting, whether these take the form of scoldings, whippings, tying the hands up, putting bitter aloes or mustard on the nails. These methods almost invariably fail, and invariably cause misery and guilt in the child. Lately, however, I have had several cases

> reported in which nail-biting has been cured, and very easily cured, by treatment of the nails with olive oil.
>
> It is clear that the physical effect on the nails of the olive oil itself must be an important factor. The oil makes the nails smooth and *soft, with no jagged edges; the child has therefore less temptation to tear at them and bite the corners off. But it is the psychological value of the jagged corners that is important* to the child, and it is the psychological service which the *mother* renders in putting on olive oil which chiefly helps the child. Nails are bitten because they are "bad" nails, because they want to scratch, because they are like biting teeth; and the more jagged and menacing they become by being bitten, the more they have to be bitten—to punish them and prevent them from scratching and biting other people. When they are softened by olive oil, they become "good" nails, loving nails, not jagged, dangerous nails, and the mother who puts on the olive oil is the helpful "good" mother, who turns them from bad nails into good, and thus helps the child not to have bad, scratching impulses. She demonstrates to the child, as it were, the possibility of their being good and loving nails, instead of bad, scratching, and biting nails (27).

Kanner summarizes the effectiveness of various cures:

> Threats, nagging, mechanical restraint, and the application of bitters have the same results in finger-sucking (are often ineffective). The treatment should begin with the removal of the causes of the tension or tensions responsible for the origin and maintenance of the habit. Appeal to the child's pride is often a surprisingly valuable therapeutic factor. It is helpful to have the youngster (his nails) *manicured a few times and then to purchase a manicuring set which he should own and use regularly. A star chart is sometimes of benefit.* Experience *shows* that the habit of nail-biting is difficult to overcome. Occupations and toys which really intrigue the patient and healthy association with other children will be of essential assistance in the treatment (30).
>
> . . . the radical methods of mechanical restraint, for which ever new devices are described and illustrated in the current medical journals, are usually ineffective; the patients return to the practice as soon as the metal or cardboard splint or sleeve is removed. Some children learn to suck the protective mittens which they are made to wear as eagerly as they sucked their fingers. The application of quinine or aloes meets similar diffi-

> culties; the children either resume the sucking at a later time or learn to indulge in spite of the bitter taste. . . .
>
> . . . In all these "cures" the children's attention is centered more than ever on the habit and, besides, they sense a certain parental force and hostility which is bound to make them contrary. They are made aware of the fact that the practice gives them an opportunity to attract attention and to worry their elders. . . . Nevertheless, mechanical means or anointment with bitters may occasionally be justified if the youngster himself expresses his desire to overcome the habit and needs a reminder which would immediately stop the hand on its way to the mouth. In this case the glove or quinine is welcomed by the child as a helpful assistance in his attempt at self-correction (29).

Louttit also discredits these methods:

> Corrective procedures utilizing restraint or bitter-tasting applications are even more contra-indicated for nail-biting than for thumb-sucking. Therapeutic measures must be aimed at relieving the underlying tension, and this involves treatment of the child's whole personality (32).

Manicures are suggested by various writers. Chapin and Royster declare, "the only successful way known to us whereby this habit may be broken is through the use of an emory board" (12). Starch, *et al.*, state:

> Time, or even money, spent on weekly manicures saves hours of nagging and irritation and brings about more satisfactory results. One practical way in which parents have coöperated with the school-age child in checking the habit has been to provide the child with a manicure set so that all rough places about the nails, which cause picking and biting, are kept smooth (57).

Guthrie emphasizes the stimulus aspect:

> The cue for the action (nail-biting) may have been the feeling of the rough edge of the nail and the removal of this cue may stop the habit, particularly when the nail is now strongly associated with the visit to the manicure and a new attitude toward nails (21).

Cameron suggests, "if the child becomes absorbed in some interesting occupation, the movements will disappear for the time being"

(11). Griffith and Mitchell think "the nails should be kept very short, and the fingers protected by gloves. In addition measures should be employed for the relief of the inherent nervous condition" (19). Morgan considers:

> The treatment for such a child is to make him feel comfortable and free from criticism. Teach him to relax and you will find that the habit will disappear of itself. Call his attention to the habit and you merely accentuate his self-consciousness and fix the habit more firmly (36).

Jeans and Rand discuss the tension:

> . . . the important thing is to relieve the emotional tension. Until this is done the nail-biting will doubtless continue and, when a well-established habit, will continue as an automatic action after the tension is relieved. After any emotional tension is relieved the important function for the adult is to find a motive strong enough to make the child want to stop biting his nails (28).

Richards also thinks along these lines:

> In children with persistent and distressing nail-biting one again seeks causes of strain and tries as far as possible to lighten their load of school work beyond their capacity, overstimulation of too frequent movies, insufficient sleep, or a nagging environment. Such children should be given every opportunity to do what they can do easily and well, but never forced to keep up to set standards. . . . It is far better to pay attention to bringing up the general hygienic standards surrounding the life of these neuropathic children (47).

Dunlap applies a specific technique which is applicable after the basic maladjustments have been alleviated. His technique also assists in facilitating the readjustment of the individual:

> In every case, the patient who shows a tic should have a competent medical examination.
>
> In spite of the need of fundamental readjustment of the patient to his environment, it remains true that in the majority of cases the habit itself needs to be broken. Here the application of the negative practice is fairly simple, and if the essential conditions of thought and understanding are secured, . . . the practice results are obtained with surprising quickness.
>
> . . . Here we might prescribe voluntary action, as in the

treatment of simple tics and stammering. In the cases of patients whose nails are already gnawed down to the quick, as is usual in confirmed cases, we hesitate to prescribe practice in further actual gnawing. Hence the form of gnawing was prescribed, without stressing the need of making it actually as savage as is the involuntary habit. Somewhat to our surprise, this practice carried out in two daily ten-minute periods succeeded with every member of a group of college students. . . . In less than three weeks, the nails had grown out to a normal length, and the biting habit was broken in every case. Practice was then suspended permanently. Complete check on the group later was impossible, on account of graduation of some of the members, but in several cases there were later relapses. Obviously, a thorough follow-up in all cases is necessary, and immediate resumption of practice is indicated at sign of a relapse. It is probable, however, that if practice had been continued on the above group *for several weeks, with lengthening intervals between* practice, relapsing would have been prevented. In some *cases, the further practice would have been superfluous (since* these cases did not relapse) but would have done no harm. *Since patients of this type can be given practice in a group, the* labor and time of the psychologist is economized, and there would have been no loss from that point of view in extending the practice of the whole group, even if it were possible to guess, at the time of the primary result, which cases would need follow-up work and which would not.

Where cases are treated singly, . . . the psychologist must proceed empirically. It is best in any case not to cease practice abruptly, but to taper it off as the particular case seems to require. Then the condition of the patient must be checked at periods varying from a week at first to a month finally.

It is quite possible that the total practice is most efficient if it is discontinued in such a way that slight relapses occur, practice being resumed promptly upon such relapse. On the other hand, this procedure may be slightly less efficient than the tapering off which permits no relapse. No decision can be made on this point at present, and its determination is obviously difficult (16).

III. PRESENTATION OF SECTIONS ON NAIL-BITING

The present inquiry consists of several years of continuous study. It covers a period of eight years, 1932-40. During the years of 1932-35 elementary school children were studied. During the second series, 1935-40, those of the tenth grade were used. Availability determined the choice of subjects. Briefly, they represent the pupils who were in regular classes during the interim, and some hospital patients.

Each year's study takes up a segment of the investigation in an attempt to verify, or discredit, hypotheses relating to the causes, correlates, incidence, and amelioration of nail-biting. An empirical approach was the initial method. Each year's findings suggested the probable area of investigation for the ensuing year. As the investigation progressed, statistical and clinical techniques supplemented the empirical approach. Wherever feasible, in order to establish rapport, an informal attitude was assumed. Otherwise, as in statistical aspects, a more formal and objective attitude was taken. Interviews, catharsis, questionnaires, students' accounts, and other techniques were used where applicable. A conscious effort has been made to present the data and its implications in as simple a manner as is compatible with the behavior investigated.

A. SECTION *A* (1932-33)

1. *Problem*

The probable relationship of corporal punishment to nail-biting, *among boys found in grades four to six, inclusive.*

2. *Procedure*

The first step was to establish a suitable rapport among the pupils. In order to accomplish this the conditions under which the data were collected were so set in time and context as to make them appear discreet to those participating. The pupils were not informed as to the real purpose of the inquiry. This was withheld in order to reduce deception. During the course of the school year the problem of finger nail-biting was considered as part of the regular class work in "health education." This was a subject in which the pupils were met. During class discussions pupils volunteered their experiences. Secondary sources were pupils' discussions of the opinions and attitudes of their friends and parents on nail-biting. These opinions and attitudes were developed in an informal manner, in a socialized recitation. At this time the incidence was established, by examining the fingers of the pupils. In this manner the 50 individuals in the experimental group were isolated. The control group was formed by matching each nail-biter with a non nail-biter in respect to age (within the same year), and *IQ* (within plus and minus three points).

In another subject, history, in which the same students were met, many of the pupils insisted on talking to their neighbors. Various methods of discipline were used to overcome this talking. These were ineffective to the degree desired. This opened the way for more severe punishment, leading eventually to corporal punishment. Offenders to receive corporal punishment, together with their offenses, were listed. One day of the week was set aside as "pay-day." The spankings served as "pay" for "enterprise." A semi-serious attitude was taken toward the procedure. The pupils enjoyed it to the extent that they were willing to take their punishment in order to see the rest receive theirs. By this indirect technique practically all of the pupils in the class, at one time or another, participated. The pupils in the experimental and control group participated at least several times.

After a time pupil resistance, in talking about spankings received at home, diminished to such an extent that these spankings could be discussed freely. There occurred some vivid descriptions of the travails of members of the class. Some seemed to glory in the fact that they could take their spanking and still not conform. These discussions aroused curiosity as to the number of pupils receiving frequent spankings. A poll was taken to ascertain the number receiving frequent spankings outside of school, from those in charge. The pupils were also asked how long they remembered these spankings. The information from these questions was collected by ballot. Each pupil wrote his name together with his responses to the questions on a sheet of paper. If the condition occurred infrequently they were instructed to write "*no*"; otherwise, "*yes*." Ballots were collected for all of the male pupils in the class, but only those of the one hundred pupils participating were used.

3. *Data*

Of the 132 boys met, 50 were nail-biters; the incidence being approximately 38 per cent.

The questions with their appropriate numerical responses will be found in Table 4.

TABLE 4

RELATIONSHIP OF CORPORAL PUNISHMENT AND NAIL-BITING
(Boys, N.—B. 50; Control 50)

Question	Nail-biters Yes	Nail-biters No	Control Yes	Control No
Do you get spankings out of School?	40	10	30	20
Do you get frightened when you are spanked?	38	12	30	20
Do you remember the spankings for some time?	20	30	25	25

4. *Discussion*

According to the cases studied, Table 4 appears to indicate that nail-biters received more corporal punishment. These children evidently annoyed those in power considerably. Although they seemed to forget the spankings rather quickly, they did indicate a feeling of fear while being spanked. There seems to be a circular condition: the nail-biter, being quite active, annoys the parents frequently. This in turn leads to spankings causing the child to experience fear and anger, and establishing a frustration in the child which will impel him to greater activity, either overtly or implicitly. One might say, a pattern has been established. Nail-biting is a segment of the entire syndrome. A slight relationship seems to exist between corporal punishment, fear, and nail-biting. The anticipation of an impending spanking (fear) is conceivably an adequate stimulus for exciting nail-biting behavior. By this is not meant that nail-biting is the only response to fear situations, merely that nail-biting is exhibited during such situations. A possible explanation for the more rapid forgetting of nail-biters may be their high activity level. Nail-biters seem to be more sensitive to impending crisis. After the situations have passed, however, they seem to forget very rapidly, going into another activity and in this manner repressing the memory of what has taken place.

5. *Findings*

Thirty-eight per cent of a random sampling of 132 boys were nail-biters.

The 50 nail-biters within this sample indicated that they received more spankings at home, for misconduct, than those in the control group.

In like manner, the nail-biters admitted more frequently that they experienced fear while being spanked than did those in the control group.

Of the cases studied, nail-biters apparently suppressed conscious memories of received spankings more than those found in the control group. They seemed to forget spankings received at school more readily, as they contributed more infractions punishable by spankings.

B. SECTION *B* (1933-34)

1. *Problem*

A survey to ascertain the distribution of nail-biting according to age, sex, grade and section, number of siblings, age at which biting began, awareness of biting, the probable causes, situations in which biting occurs, and sense of guilt felt by the biter.

2. *Procedure*

At the beginning of the 1933-34 school year, it was decided to verify the number of nail-biters in the various sections met. During the month of September, of that term, this was done by circulating a sheet of paper among the pupils, upon which the nail-biters were asked to sign their names. A new sheet of paper was used for each section. The actual occurrence of nail-biting was verified by inspection of the pupils' fingers. A few were found who bit their nails, but who had not signed the paper. After verification of this, these names were added.

All the nail-biters met in the various sections were given a mimeographed questionnaire, a facsimile of which follows:

1. Name.
2. Age.
3. Grade and Section.
4. Number of brothers and sisters.
5. Age, when started to bite nails.
6. Do you know when you are biting your nails?
7. Anything you can remember of when, and how, you started to bite your nails.
8. Under what conditions do you bite them now?

To determine the reliability of factual statements the school records were used, wherever feasible, to supplement the questionnaire.

3. *Data*

The 223 pupils met were utilized for the year's work. Of these, 89 were nail-biters. The remaining 134 constituted the control group. The pupils participating in this study were from Grades 4, 5, and 6; Sections *A, B,* and *C.* Grade 4-*A* means Grade 4, Section *A* (Table 5). Pupils were placed in sections according to their ability. The *"A"* sections consisted of the more intelligent pupils; the *"C"* sections represented the less intelligent. The Stanford Revision (1916) of the Binet-Simon tests was the basis of determining mental ability. This had been administered during the time the pupils were in the first grade.

The results of the tabulation of some of the facts arising from the questionnaire will be found in Table 5. From the grade totals (Table 5) it is evident that 41 cases, or 36.3 per cent of the boys were nail-biters, whereas 48 cases, or 41.1 per cent of the girls indulge in this practice. The 89 cases of boys and girls, or 39.9 per cent, were the total number of nail-biters within the experimental group. The nine-year-old pupils within this study show the highest frequency of nail-biting. Of the 90 who were nine years old, 40 were nail-biters, or 44.4 per cent (Table 5).

Table 6, indicating the number of siblings, is supplemented by data from another study (67).

During the collection of data on the number of siblings, the collection of information for the purpose of a control was overlooked. At the time, it was of interest to determine only the most frequent number of siblings occurring in the nail-biters' families. By coincidence it was found that L. Viets had in a somewhat similar study compiled information on the same question. The liberty was taken to fill this deficiency for a control by using her control group.

Eighty-six nail-biters were used in Table 6. The discrepancy between the number of nail-biters found in Tables 5 and 6 is due to the fact that several pupils were transferred in the interval between collecting and tabulating the data. As two of these pupils' answers were illegible, and another questionnaire unanswered, these cases were ignored. This changed the number of cases from 89 to 86.

The incipiency of nail-biting is presented in Table 7.

TABLE 5

DISTRIBUTION OF NAIL-BITING ACCORDING TO AGE, SEX, GRADE, AND SECTION

Age	Boys N.B.	Boys Con.	Girls N.B.	Girls Con.	Total N.B.	Total Con.	Total number
			Grade 4-A				
8	0	4	3	7	3	11	14
9	6	6	8	9	14	15	29
10	0	0	0	0	0	0	0
11	0	1	0	0	0	1	1
Total	6	11	11	16	17	27	44
			Grade 5-A				
9	3	4	3	11	6	15	21
10	3	3	1	3	4	6	10
11	1	0	0	0	1	0	1
Total	7	7	4	14	11	21	32
			Grade 5-B				
9	1	8	5	2	6	10	16
10	0	6	4	1	4	7	11
11	0	1	0	0	0	1	1
12	0	0	1	0	1	0	1
Total	1	15	10	3	11	18	29
			Grade 5-C				
9	6	3	4	3	10	6	16
10	4	2	4	2	8	4	12
11	1	3	0	0	1	3	4
12	2	0	0	1	2	1	3
13	1	0	0	0	1	0	1
Total	14	8	8	6	22	14	36
			Grade 6-A				
10	3	11	0	2	3	13	16
11	1	7	4	11	5	18	23
12	0	0	0	2	0	2	2
13	0	1	0	0	0	1	1
Total	4	19	4	15	8	34	42
			Grade 6-B				
9	1	0	3	4	4	4	8
10	4	2	2	3	6	5	11
11	2	4	4	1	6	5	11
12	1	4	2	0	3	4	7
13	1	0	0	0	1	0	1
14	0	1	0	0	0	1	1
15	0	1	0	0	0	1	1
Total	9	12	11	8	20	20	40
Grade total	41	72	48	62	89	134	223

TABLE 6
SIBLINGS

	Both sexes	
No. of siblings	Nail-biters	Control (67)
1	2	10
2	12	20
3	24	21
4	15	6
5	6	7
6	6	4
7	4	4
8	3	3*
9	3	..
10	6	..
11	3	..
12	2	..
Total	86	75

*Eight of more siblings.

TABLE 7
INCIPIENCY

Age started	Nail-biters	Per cent
Under 4 years	0	0.0
4	2	2.3
5	6	6.7
6	14	15.7
7	18	20.2
8	16	18.0
9	23	25.8
10	7	7.9
11	2	2.3
12	1	1.1
Total	89	100.0

Eighty-one of the 89 nail-biters were aware of the act of biting. This indicates that 91 per cent knew when they were biting their nails.

Representative answers to question seven: *Anything you can remember of when and how you started to bite your nails?*

> I began to bite my nails at the beginning of last year. I saw someone else bite them, so I began to bite them. I was excited.
>
> I learned to bite my nails from my sister and brother.

My girl friend bit her nails, so I did.

I started because when I became nervous I could not resist the temptation. I learned from my brother.

I learned from another girl, I watched her, then I started it too. I bite them every time I get a spanking.

I started to bite my nails when I started school. I used to get scolded.

When I was small I went to a movie and it was about a fire, after that I was afraid of fire, and every time I think of it I bite my nails.

I learned from my playmate, when I started school. I bite them because I am nervous.

I started to bite them when I was seven. They were too hard to pick off so I bit them.

I started to bite my nails last year. I saw almost all the girls in our club do it so I did it too.

Representative answers to question eight: *Under what conditions do you bite them now?*

I find myself biting my finger nails usually when I get nervous or excited over something, and perhaps biting them so long it has become a habit with me.

I bite my nails when my mother gives me a scolding.

I bite my nails when I get scared.

I bite them because I am very nervous.

I bite them when I go to the movies, school, and church.

I bite my nails when I have home work to do and don't know how to do it. When I do something wrong and get a scolding.

When I get afraid, and when somebody is sick. When the teacher asks me something. When I must go someplace and I don't know where it is. When somebody gets hurt. When I go to the store and forget something.

I chew them when I have nothing to do.

I bite my finger nails in church.

Because I get nervous in school and don't know what to do next.

My finger nails make me do it.

I bite my finger nails when I see something exciting. When I see children hit with a machine, and when I must hurry and can't.

I bite them in school, church, or when anybody scolds me.

I bite them when I get excited, when I don't know my lessons, or when I do something I'm not supposed to do.

I bite them when I get excited, or worry about something.

I bite my nails when I get excited and scared, and when I see spooky movies.

4. *Discussion*

The precipitating factors were found in situations in which the individual responded unsagaciously. The nail-biters tended to be reluctant in discussing these situations. During interviews, after rapport had been established, the information seemed to burst forth. One gets the impression, as this outburst takes place, that the narrator is not exactly aware of what he is saying. There is definite evidence of emotional loading. Even in the rehearsal of these past events the pupil generally exhibited intense emotional patterns. When questions were asked concerning former statements, in order to obtain additional information, the pupil would often, almost vehemently, deny that he had made such statements. During further inquiry, after the emotional discharge had occurred, the pupil would oftimes admit, rather apologetically, that these facts had been true. Pupils would confide then that they had often thought these things over to themselves, but were too ashamed to say anything to anyone else. The tendency to retract statements is probably due to a feeling of guilt. As these events were reconstructed in the light of the pupil's present experience the emotional tensions seemed to disappear. The individual's response (nail-biting) is determined largely by past contexts, rather than by the present situations. Nail-biting might be considered a diffusion in that it helps the individual in dissipating emotional tension; as these individuals exhibited a high activity level. In that it is a socially inadequate behavior, nail-biting can be considered neurotic.

The affective element associated with nail-biting was found to be fear. In the "*A*" sections the causes for fear were found to be mostly symbols, words, and ideas. In the "*C*" sections the causes were found to consist, generally, of more material objects such as the paddle, lack of food, being locked in a closet for misbehaving, shouted at, seeing people hurt, etc.

The immediate purpose which nail-biting seems to serve is to postpone a perceived difficulty or an impending annoyance.

5. *Findings*

The range of ages studied was from eight to sixteen years, inclusive.

It was found that 36.3 per cent of the boys, and 41.1 per cent of the girls; or 39.9 per cent of the total number were nail-biters.

Of the nine-year-old pupils 44.4 per cent were nail-biters.

The results show that in the *"A"* sections there tends to be a smaller proportion of nail-biters, whereas in the *"C"* sections a much larger proportion is found. The section containing the largest proportion of nail-biters was Section 5-*C* having 61.1 per cent.

Nail-biters occurred frequently in families of two and four children, and most frequently in 3-child families. It is likely that the 3-child family occurs most frequently in the population at large.

There is a decided rise of incipiency in the sixth year; with the greatest, or 25.8 per cent, occurring in the ninth year. During the tenth year there is a decided drop.

According to the pupils' testimony, a great majority of nail-biters were aware of the act of biting.

During interviews the nail-biters displayed evidence of a sense of guilt.

Fear was found to be a conspicuous factor in situations reported by the pupils, in which nail-biting occurred.

Among the cases investigated, the precipitating factors were found *in the individuals' past.*

Nail-biting is essentially a learned behavior developing, however, *on the basis of predispositions which are not common or constant in* all individuals. In our culture this behavior is not formally taught; however, some of the students indicated that they started this form of behavior by choice after having observed someone else indulging in it. If the individual indulging possessed status, as far as the observer was concerned, and the observer possessed suitable (emotional) predispositions, the learning of nail-biting followed. In this way the former individual unintentionally taught this behavior to the latter.

C. SECTION *C* (1934-35)

1. *Problem*

A study to find the incidence of nail-biting according to grade and section, sex, and intelligence; to find its duration among present nail-biters; to determine, by use of a standardized questionnaire, the extent to which nail-biters are neurotic; to suggest a treatment of nail-biters by means of negative conditioning.

2. *Procedure*

This section of the investigation was conducted during the school year of 1934-35.

The incidence of nail-biting was determined by inspection of the pupils' fingers, during regular class period. A distribution was then made according to grade and section, and sex, for the nail-biters and the control. The control group consisted of all the non nail-biters in these class periods.

To find the duration of the habit, the pupils were asked to verify at what age they had started to bite their nails by asking their parents, as well as through their own recollection. From this information, together with the knowledge of the pupils' present age, the duration was determined.

In a preceding study (1933-34) evidence was revealed that nail-biters are neurotic. In order to establish to what extent nail-biters are more neurotic than non nail-biters the Woodworth-House *Mental Hygiene Inventory* was used. Sheets of paper, numbered from one to thirty, were given each pupil. The questions from the inventory were read aloud, and the pupils instructed to write *"yes"* or *"no"* for each question as it was read. If the condition mentioned in the question happened frequently the pupils were instructed to write *"yes."* On the other hand, if it was of infrequent occurrence they were told to write *"no."* Ample time was given, between the reading of each question, for the pupils to make their decisions. The total number of *"yes"* for each item was computed, for both the nail-biting and non nail-biting girls. This was also done for both the nail-biting and non nail-biting boys. These totals, for both the nail-biters and non nail-biters for both sexes, were converted into percentage. The difference in percentage, between the nail-biters and non nail-biters, was computed. The control group was used as the standard. The deviation in percentage was recorded in both positive and negative values, e.g., 24 per cent of the girls in the control group answered *"yes"* to item one; for this same item 23 per cent of the nail-biting girls answered *"yes."* This gives us a difference of minus one per cent, for the nail-biters. In like manner, for

Item 3, 34 per cent of the control group answered "*yes*," whereas, 63 per cent of the nail-biters answered "*yes*." This gives us a difference of plus 29 per cent for the nail-biters.

The *IQ* was taken from the school record. These *IQ*'s were determined by the Standford Revision (1916) of the Binet-Simon tests. In most cases these tests were given during the first year of attendance at school. Due to the occurrence of transfers some were administered at a later date.

As any kind of systematic treatment would of necessity take up a good deal of time, permission was received from the school superintendent to incorporate it as a project in health education. The school physician gave his permission to use a quassia solution on the children's fingers. It was then expedient to receive permission from the parents of these children. Four of these parents refused their permission, while 123 acquiesced. This is the reason for the discrepancy between the cases of nail-biting found and the number treated. The total number of cases was 212, of which 127 were nail-biters. The remaining 85 cases were utilized as the control group. The preparation of the quassia solution was as follows: an ounce of quassia chips was added to a pint of hot water and steeped until cool, after which it was strained. The solution was bottled, to be used as needed. This solution was applied to the fingers with a cotton-tipped applicator. In some of the sections the quassia was also put on the side of the tongue, using the same procedure as when putting it on the fingers. Treatments were given weekly, for a period of two months, November and December. An attempt was made to create an intense desire to let the nails grow. The treatments were explained as an aid to speed-up the stopping of this form of behavior. When the treatments were started, all the nail-biters who had received permission from their parents were given a treatment. The following week, before a treatment was given, the pupil was asked if he had stopped biting. If he answered in the affirmative he was given another treatment, nevertheless. This was done to prevent pupils from saying they had stopped, simply to evade treatment. The following week the pupils who had reported stopping the previous week had their fingers re-examined. If there was evidence of stopping no treatment was given. Pupils who had stopped biting were praised in front of the class in order to establish a pleasant feeling-tone with allowing the nails to grow. This praise also gave them the feeling of social approval. Pupils who had received treatment were not allowed to get a drink of water during the class period. Those who stopped biting during this two-month period, but later relapsed, were given occasional treatments. Those pupils who had not responded to the treatments during this period were dropped.

3. *Data*

The number of cases used totaled 212. They consisted of pupils in the fifth and sixth grades. Of the total number there were 127 nail-biters. The remaining 85 were used as the control group. The distribution according to grade and section, and sex is given in Table 8.

TABLE 8

INCIDENCE OF NAIL-BITING DURING 1934-35

	Boys		Girls		Total		Total	Per cent
	N.B.	Con.	N.B.	Con.	N.B.	Con.	number	biting
*6-A	9	7	6	12	15	19	34	44.1
6-B	10	11	8	7	18	18	36	50.0
6-C	9	3	6	4	15	7	22	68.2
5-A	8	6	16	8	24	14	38	63.2
5-B	14	13	13	4	27	17	44	61.4
5-C	20	7	8	3	28	10	38	73.6
Total	70	47	57	38	127	85	212	59.9
Per cent	58.8		60.0					

*6-A signifies Grade 6, Section *A*, etc.

The information pertinent to the duration of nail-biting is summarized in Table 9. It will be observed from this table that ap-

TABLE 9

DURATION OF NAIL-BITING

No. of years	Frequency	Per cent (app.)
1	8	6.
2	32	25.
3	24	19.
4	28	22.
5	9	8.
6	12	9.
7	8	6.
8	6	5.
Total	127	100.

proximately 66 per cent had been biting their nails for a period of two to four years. The modal year was two.

The information in respect to intelligence is presented in Table 10.

TABLE 10

DISTRIBUTION OF INTELLIGENCE

Range (*IQ*)	Nail-biters	Control	Total
Below -69	10	4	14
70-79	19	8	27
80-89	36	20	56
90-99	42	28	70
100-109	10	16	26
110-119	6	8	14
120-Above	4	1	5
Total	127	85	212

Since the number of cases is comparatively small, the *IQ*'s are arranged in intervals of 10 points. All those of 70 and below are grouped in one step. In like manner, all those above 120 are grouped in a single step.

The questions (items) of the questionnaire used which gave differences from the control of 10 per cent or more, are listed for the boys in Table 11.

TABLE 11

SIGNIFICANT ITEMS FOR BOYS: NAIL-BITERS

Rank	Item	Per cent in excess of control
1	Temper tantrums	21
2	Mind-wandering	16
3	Disliking company of girls	15
4	Low marks in school	14.5
5	Poor health	13.6
6	Fright in middle of night	12.4
7	Consider myself rather nervous	10

In like manner, the significant items are summarized for the girls in Table 12.

On the item relating to the "feeling of inferiority," 66 per cent of the control group indicated its presence, whereas only 47 per cent of the nail-biters (girls) did so, or a difference of 19 per cent.

The total responses, omitting the question referring directly to nail-biting, are shown in Table 13.

TABLE 12

ignificant Items for Girls: Nail-Biters

tem	Per cent in excess of control
in middle of night	29
g ashamed (interest in body)	18
bed over sex	13.5
changes in interest	11.2
lering myself rather nervous	11
g tired easily	10

TABLE 13

Affirmative Answers to Questionnaire

Boys		Girls		Total		Total
N.B.	Con.	N.B.	Con.	N.B.	Con.	number
70	47	57	38	127	85	212
988	551	861	517	1849	1068	2917
14.1	11.7	15.1	13.6	14.5	12.6	

pertaining to the treatment is presented in three
he form of a typical treatment curve, in Figure 1;
of the treatments, of the six sections, in Table 14;
raph, Figure 2, which depicts the relative proportion
er section, before and after the treatments.

sted that if the data resulting from the treatment of
egative conditioning were plotted to form a graph
in a "J-curve," and would illustrate his concept of a

TABLE 14

Treatment of Nail-Biters: Both Sexes

Grade 6			Grade 5		
A	*B*	*C*	*A*	*B*	*C*
15	18	15	22	27	26
7	12	9	14	25	20
4	11	8	8	20	10
4	8	7	8	11	7
4	6	7	8	5	6
3	4	7	6	4	6
3	4	7	4	4	6
3	4	7	4	4	6
3	4	7	4	4	6

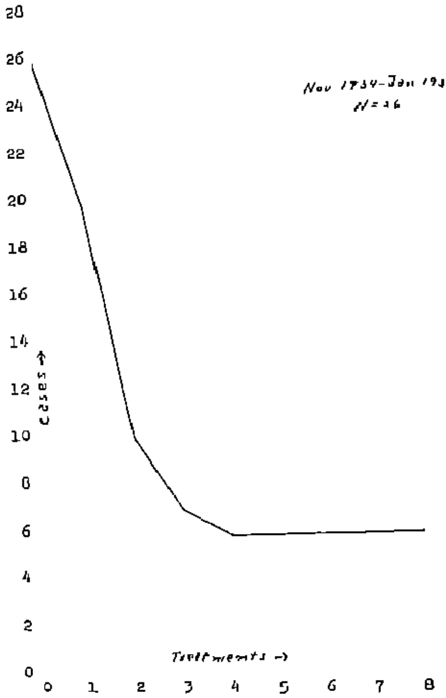

FIGURE 1
"J-CURVE" DEPICTING TREATMENTS OF NAIL-BITERS, OF GRADE 5-*C*, BY NEGATIVE CONDITIONING

"telic continuum." All six curves being "J-curves" only one, that of Grade 5-*C*, is given (Figure 1).

The decrease of nail-biting, for each of the six sections treated, is shown in Table 14.

To summarize the data of the preceding table (Table 14) a summarizing table was computed indicating the per cent biting at each of the treatments, and the net gain in per cent between the successive treatments. This is shown in Table 15.

To assist in evaluating the success of the treatments, and to present the results pictorially a bar graph (Figure 2) was constructed. It is of the split type; the right side indicating the nail-biters, and the left side the non nail-biters.

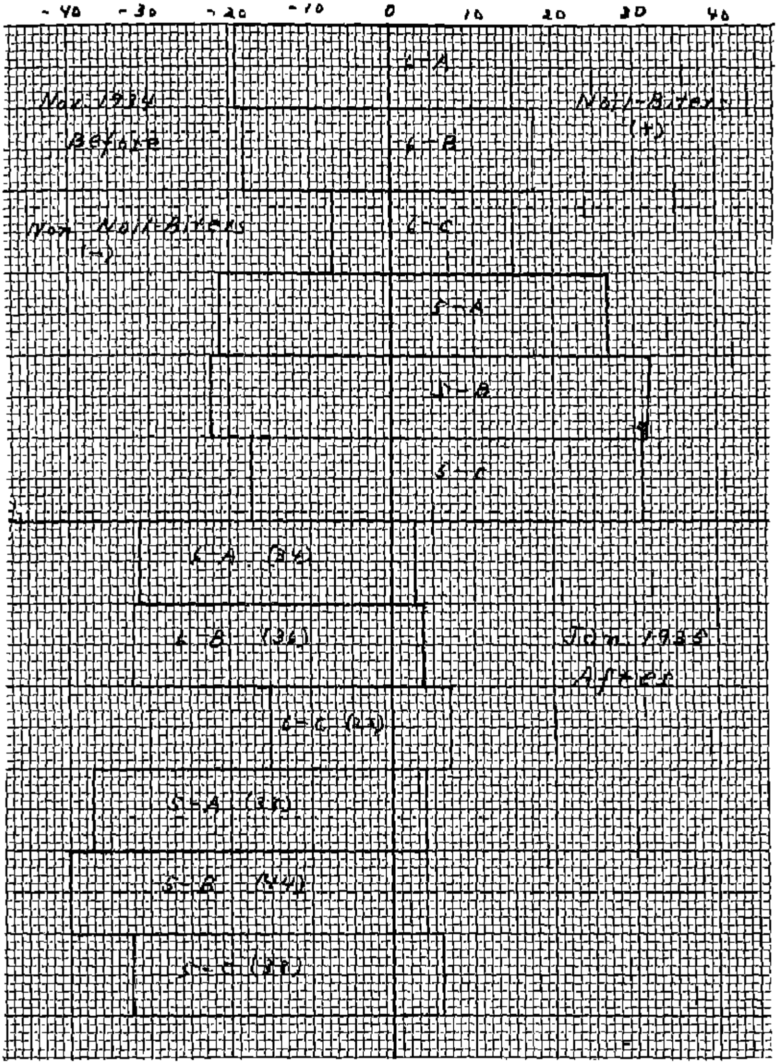

FIGURE 2
DISTRIBUTION OF NAIL-BITERS BEFORE AND AFTER TREATMENTS; ACCORDING TO SECTION

TABLE 15
SUMMARY OF TREATMENTS: BOTH SEXES

Treatments	Nail-biters	Per cent	Per cent of decrease
0	123	100.0	....
1	87	70.7	29.3
2	61	49.6	21.1
3	45	36.6	13.0
4	36	29.3	7.3
5	30	24.4	4.9
6	30	24.4	0.0
7	30	24.4	0.0
8	30	24.4	0.0

4. *Discussion*

During this investigation, the incidence of nail-biting was found to be practically the same for both sexes. The fifth grade sections contributed more than those of the sixth grade. The *"C"* sections in both the fifth and sixth grades showed the highest incidence.

In respect to the duration of nail-biting, it definitely appears that the great majority have been doing it for quite some time. There seems to be a peculiar bunching in the two- to four-year interval.

This leads one to believe that the learning of this behavior takes place in what is generally known as the primary grades. This may be due to the need for adjustment to numerous different personalities with which the child has had no previous contact. This doubtlessly leads to many frustrating situations as the range of competition is far greater than that encountered previous to school life.

Considering the smallness of the sample, and the character of the distribution, it seems hazardous to venture a definite statement regarding the intelligence of nail-biters as compared with non nail-biters. However, the nail-biters contributed more cases proportionately in the intervals below 100, and in the interval of 120 and above. The non nail-biters contributed more cases proportionately in the intervals of 100 to 120.

The item analysis for the "Mental Hygiene Inventory" reveals enlightening facts. The first item on the boys' list is "temper tantrums." This ties *with the study conducted in* 1932-33, *pertaining* to corporal punishment. Temper tantrums certainly enter into the picture of corporal punishment. The claim of the male nail-biters that they forget spankings quickly (1932-33) is in part verified by the fact that "mind wandering" is the second most significant item. The only item that may possibly have a sexual implication for boys is the one pertaining to "disliking the company of girls." This item ranked third. The succeeding four items: low marks, poor health (imagined), fright in the middle of the night, and considering themselves nervous, all point to the importance of fear. Collectively, these seven items give a fairly adequate description of the nail-biting boy.

One would almost believe that since nail-biting occurs in both boys and girls they would be the same kind of individuals. This is not true, however. With girls there is a greater preponderance of items related to sex, as feeling ashamed of interest in their body, and being disturbed over sex. The most significant item among girls, that of "fright in the middle of the night," indicates the importance of fear. They also report that their interests change quickly, and that they believe themselves to be nervous. The sixth item, that of "getting tired easily," may be due to the rather constant domination of the sympathetic division of the autonomic nervous system. The girls indulging in nail-biting show much less evidence of a "feeling of inferiority" than the control, indicating that they have a higher self-regard than those of the control group.

As a whole, the questionnaire shows a slight difference of neurotic scores, indicating that the nail-biters are slightly more neurotic than the control.

In the cases where the treatment with quassia solution effected a cure, it usually took place within the first three treatments given. Additional treatments seemed increasingly ineffective. There probably occurs an adaptation to the treatment, rendering it ineffective. It follows, if this procedure is to succeed it will do so within the first few treatments, otherwise it will only tend to stabilize, to a greater extent, this behavior. Each treatment was succeedingly less effective, and after the fifth treatment no further improvement took place. Desisting being, primarily, a conformity situation, those who do conform do so rather quickly. The remaining nail-biters persist in this behavior. Those who do not respond prefer the satisfaction derived from nail-biting, and willingly tolerate the discomfort of the quassia solution. To these, nail-biting satisfies a definite need. In cases where this behavior ceases there is no strong "felt" need for this form of behavior. Approximately 75 per cent of the cases did respond to this treatment. There is a strong possibility that some of these cases, after the completion of this experiment, did relapse.

5. *Findings*

In the six sections studied the greatest incidence, 73.6 per cent, was among pupils in Grade 5-*C*; and the least, 44.1 per cent, in Grade 6-*A*.

Of the 212 cases studied, 127 were nail-biters, or 59.9 per cent. Of these 127 cases, the girls contributed 60 per cent; the boys 58.8 per cent.

It was found that 66.1 per cent of the nail-biters had been indulging from two to four years, inclusive. The modal year was two.

As a group, nail-biters have a slightly lower mean *IQ* than those who do not indulge. Those with lower intelligence quotients contribute more nail-biters than those of higher intelligence.

The incidence is greater in the fifth than in the sixth grade.

According to the scores made by the nail-biters on the "Mental Hygiene Inventory," they appear slightly more neurotic than the non nail-biters.

Significant items for boys were: temper tantrums, mind wandering, disliking company of girls, low marks in school, poor health, considering themselves rather nervous, and fright in the middle of the night.

Significant items on the "Mental Hygiene Inventory" for the girls were: fright in the middle of the night, feeling of superiority, feeling ashamed, disturbed over sex, swift changes in interest, considering themselves rather nervous, and getting tired easily.

At the conclusion of the treatment 75.6 per cent of the cases treated had desisted. This indicates that this procedure will facilitate, at least, the amelioration of nail-biting provided the nail-biter sincerely desires to cease this form of behavior.

The first treatment effected the greatest decrease in nail-biting, 29.3 per cent. Each succeeding treatment diminished in effectiveness until the fifth treatment, after which no further decrease occurred.

D. Section *D* (1935-36)

1. *Problem*

l year was devoted to evaluating the appropriateness ethods of investigating finger nail-biting among tenth o develop skill in the observational technique, and to ysis of the nail-biting activity.

2. *Procedure*

evious studies had been conducted with elementary n it did not follow that the same procedure would, applicable to tenth grade girls. Accordingly, it was tial to determine, empirically, what techniques or ap- d be utilized. Those which seemed to give at least of reliability and validity are reported.

ject taught was commercial arithmetic, the problem could not be incorporated to any degree of consistency e regular class work. This left as an alternative, de- in observation. Usually more than half of the class ent by the pupils working problems at their seats. This le opportunity for the observation of nail-biting. The to be overcome was that of being able to observe the her nails without having her become aware of this It developed that by reducing facial response to a nding or sitting as still as possible, and appearing to pupil without responding to her activities, the pupil of being observed. Another method was to stand the room so that a clear view of the pupil's hands and er face was visible. It became apparent after a period rvations that nail-biting could be divided into four

ethod tried was that of informal discussion. The day usual school vacations as Thanksgiving and Christmas, ar class periods, various questions pertaining directly were posited for discussion. The reason for using as the fact that the students already had the festive facilitated the interchange of ideas. Those questions d some evidence of successfully serving the purpose reported. On one of these occasions, after some informal discussion about the time and cause for nail-biting, four persistent indulgers were asked to write their explanations. These were collected. This was to determine the type of response tenth grade girls were likely to give.

The cathartic method was used, in another period, with five chronic nail-biters. The earliest situation (presumably the inciting situation) in which they were certain they had bit their nails was to be recalled. After one minute of recalling and isolating this situation they were asked to tell the interviewer anything they could remember about it. The maximum time allowed for such an abreaction was from 10 to 20 minutes. After this a memorandum was made.

In another class, entertainments in which the pupils frequently participated were discussed, such as movies, dancing, parties, games, and picnics, together with their respective implication to nail-biting. The consensus of the 10 nail-biters in this period was taken. The entertainments were named and the nail-biters were asked to raise their hands when one was named in which they consistently bit their nails. The number of hands raised was tabulated, for each of these various forms of entertainment.

At another time, in a class containing nail-biters, tests and their effect on the incidence of nail-biting were discussed. The nail-biters' reasons for indulging were sought. These were listed.

Still another method employed was the holding of an impromptu forum. The question discussed was: *Do nail-biters stop this behavior gradually or suddenly?* The principal participants in this forum were the former nail-biters. Other members of the class participated in the general discussion which followed. Pupils tended to stray from the topic under discussion and had to be directed back to it.

3. *Data*

The four postures into which nail-biting, by girls, can be divided are: (*a*) The placing of the one hand in the vicinity of the mouth. This posturing continues from a few seconds to half a minute. (*b*) The placing of the finger against the teeth. This step is usually accomplished very rapidly. (*c*) A series of quick, spasmodic bitings, with the nail of the finger pressed tightly against the biting edge of the teeth. (*d*) This step consists of the withdrawal of the finger from the mouth, to be inspected either visually or to be felt by another finger or by the other hand. The facial expression at this period is rather serious. If the biter becomes aware of being watched the proceeding is abruptly brought to an end. The entire sequence lasts anywhere from about 40 seconds to several minutes.

The testimony of four high school sophomore girls as to the time and inducement for them to bite their nails is as follows:

> When I get excited. After I have an argument with a close friend.
>
> I usually do it when I am excited or cannot do something. Or when I sit around and have nothing to do that I like.
>
> I bite my two finger nails on my left hand when I am at the movies and the picture is exciting.
>
> Sometimes I get nervous when I have to say a speech or something like that, then I usually bite my nails. I usually bite my nails when I am reading a book or a magazine.

During the abreaction, the incident recalled was usually one that occurred during early childhood. Nail-biting was considered to be consistent behavior with their idea of themselves.

The stimulus value of various forms of entertainment are ranked in Table 16.

TABLE 16

STIMULUS VALUE OF ENTERTAINMENTS TO NAIL-BITERS AMONG TENTH GRADE GIRLS

(Ten Cases)

Rank	Entertainment	Frequency
1	Motion pictures	10
2	Games	8
3	Stories	6
4	Dances	4
5	Daydreaming	3
6	Parties	2
7	Picnics	1
8	Dates with boys	1

In the test situation the reasons for biting are largely those which show the need of more effort being put forth by the individual during this activity. Various phrases were used to describe these situations such as: *"when I have to try very hard"; "I do not understand what the problem says"; "it seems to help me to try harder";* etc.

Of the 28 individuals participating in the forum, 20 believed finger nail-biting stopped rather abruptly.

4. *Discussion*

The information obtained from the testimonies of the sophomore girls is probably true as far as it goes.

The abreaction tended to show how this form of behavior becomes assimilated as part of the personality of the individual displaying it. It appears consistent with their idea of themselves to the extent of trying to justify its consistency with the rest of their behavior.

The fact that the 10 cases studied claimed they bit their nails while attending motion pictures indicates its stimulus value to be high. Yet, these same individuals maintain they enjoy motion pictures immensely, especially the thrilling kind. In like manner, games, and stories of the thrilling type are preferred. The four girls who indulged at dances say it occurs, usually, while waiting to be asked to dance. Parties, picnics, and dates with boys appear to have low stimulus value for this form of activity.

Probably the suddenness of desisting, of various nail-biters, may be due to their having achieved greater insight, and the need for this behavior no longer existing.

The observational method appears to be both reliable as well as valid. Here deception is almost impossible. The questionnaire ranks second, with discussion third.

5. *Findings*

Nail-biting activity often follows a sequence of four rather distinct postures for girls.

Nail-biting occurred, for the sophomore girls, when they were in a state of excitement. Also when they are unable to do something which they desire to do.

Nail-biters usually believe this form of behavior to be consistent with their definition of self.

Of the various forms of entertainment indulged in by tenth grade girls motion pictures and games are the most provocative.

During the test situation, those parts requiring the most effort to solve are the most likely to elicit this form of behavior.

Most of the pupils believe nail-biters stop this behavior abruptly.

E. SECTION *E* (July 6 to August 26, 1936)

1. *Problem*

This study was undertaken in an attempt to determine the incidence of finger nail-biting among the girls in the children's ward of the Allentown State Hospital; the value of olive oil in the treatment of such cases; and what their parental relationship had been prior to their commitment, by studying their case histories.

2. *Procedure*

The fingers of the children were inspected to find the number biting their nails. The nurses in charge of the respective children were interviewed in regard to the patients' general behavior. The superintendent, Henry I. Klopp, authorized the nurses to treat the nails of these patients with olive oil three times daily, morning, afternoon, and shortly before retiring. Each nurse was assigned two nail-biters whom she was to treat, observe, and report on. The teacher in charge of occupational therapy was also interviewed in respect to these patients. The writer interviewed the nail-biters at least twice a week. During these interviews the progress of the treatment was noted, and further information about their nail-biting was sought by means of direct questioning. The case histories of the nail-biters were read and pertinent excerpts taken therefrom, for future reference. The psychiatrist in charge, Max Rosman, offered his own observations of previous nail-biters under his care.

3. *Data*

Of the patients present at the onset of this study, approximately 25 per cent were finger nail-biters.

During interviews with the patients the following questions were asked:

1. What are you thinking about when you are biting your nails?
2. How did you start biting your nails? Do you know when you are biting them?
3. Did any of your friends bite their nails?
4. Why do you think you bite your nails?
5. Did anyone scold or tell you to stop biting your nails?
6. Do you get sleepy when you bite your nails?
7. (*a*) What are your hobbies? (*b*) Do you bite your nails when you are working or playing at your hobby?

In general, the answers given by the patients during these interviews must be considered unreliable. They were evasive, the answers oftimes resulting from cues given by leading questions. Other times they failed to answer the questions by saying, *"I don't know,"* or by sheepishly smiling. Lying appeared promiscuous. The following are *indications of the* results obtained during these interviews:

1. No general tendency can be indicated, due to the confusion of the responses, except that the patients were in a stirred-up state.
2. The patients did not seem to know how they started to bite their nails. Most of the patients claimed they were not aware of the act of biting.
3. In many cases their mothers, or relatives with whom they came in contact, bit their finger nails. Occasionally a playmate indulged in this practice.
4. *Practically all of the answers received on this question* were of the type that would be expected from adults. The patients probably heard these answers, at some time or another, and were merely repeating them. They had no insight as to the significance of these answers, nor as to the reason for biting their nails.
5. In almost every instance someone had tried to stop them from indulging in this practice, or scolded them for doing so.
6. This question was used to check the validity of the other answers. Some of the answers were in the affirmative.
7. (*a*) Responses as to their hobbies were profuse and extensive, the patients exhibiting no noticeable inhibitions. (*b*) The consensus was that they very seldom bit their nails while occupied with their hobby. This was substantiated by the supervisors of occupational therapy.

Excerpts from some of the case histories studied together with the results obtained from the treatments with olive oil, as observed during the interviews, are presented:

Catherine, female, age—12, IQ.—84.

Treatment: Nails chewed badly, rough and dirty. After treatment with olive oil, and interviews, condition improved somewhat.

Problem: Quarrelsome, wets her bed, and masturbates.

Family: Family separated, mother immoral, father very emotional.

Behavior: She was stubborn and obstinate . . . she was nervous and restless and showed undue interest in men.

Rose, female, age—9, IQ—86.

Treatment: After treatment nails showed some improvement. Very coöperative during interviews. Stated mother would like her to have nice nails.

Problem: Mother says, "she has become unmanageable, attacking other pupils, and at home attacking her siblings and mother."

Behavior: She has been, aside from the usual behavior, masturbating, and pulling at her hair, experiencing quite some instability and anxiety. . . . She also pulls out her hair and swallows this. . . . She will play with toys for a few seconds, then throws them down angrily, and destroys anything she gets hold of.

Elma, female, age—14, IQ—79.

Treatment: Says she would like to have nice nails, but there was no improvement from the treatment. She chewed her nails as badly at the end of the treatment as at the beginning.

Problem: Incorrigibility, claimed by mother.

Family: The mother is a harsh, easily irritated person who has frequent spells of temper.

Behavior: Resents home, blames difficulties on mother. She can be loud and boisterous, like the others. When admitted to the hospital—seemed excited.

Ellen, female, age—12, IQ—113.

Treatment: Left institution a few days after treatment started, but during that time had completely stopped biting her nails. Her nails were well manicured, and clean. Saw someone with nice nails and she decided she wanted her nails to look like theirs.

Problem: Inability to get along with her parents. Temper tantrums, and epileptiform seizures, became irritable and disobedient.

Family: Mother was very fussy. Father very nervous.

Behavior: She displayed temper tantrums, and histroepilepsy.

Dorothy, female, age—13, IQ—78.

Treatment: Treatment seemed to do very little good. Nails were chewed very badly.

Family: Family history negative on both sides.

Behavior: She never attended school. Is impulsive and hasty. Talks a good deal and is restless. Does not like school, it is too hard. Restless, overactive, overly interested in opposite sex.

She demands a great deal of attention from the physician. She was diagnosed as "habit disturbance."

Pearl, female, age—9, IQ—84.

Treatment: After treatment, showed some improvement. During interviews she was very evasive. She lied consistently, saying she did not bite her nails, but on observation found they were badly chewed.

Family: Mother immoral and mentally ill. Father committed suicide in 1933.

Behavior: She has had numerous infections about the finger nails, from picking and tearing the skin. She has also been pulling at her hair. This occurs at night when she is in bed. She resents being put off, whenever she has some simple slight wound on her skin or fingers, usually self inflicted. . . . She pulls out her hair during fits of temper. At other times she is shy.

Rose Marie, female, age—11, IQ—81.

Treatment: Treatment apparently did very little good. Lies promiscuously. Chewed her nails as badly as before, but always had an alibi.

Problem: Bad temper, restlessness, destructiveness, and sex delinquency.

Family: Father weak type, mother immoral and of low type. Left husband and lives with another man, and has had several children.

Behavior: Destructive, overactive, assaultive, distractable, unstable, disrespectful, quick tempered, masturbates, and is stubborn.

4. *Discussion*

The evidence submitted by the nurses was found to be unreliable in some aspects. They tended to state their opinions rather than report factual results. Three of these reports, received from nurses, are given:

> All children seem to be nail-biters. It seems to be true especially of nervous children. I noticed that many of the girls in C. W. had nails that were very short, but after being told about them, and encouraged to let them grow, they seemed to improve. To help them I put olive oil on as was prescribed and also gave them finger-nail polish. All girls have a certain amount of pride, so by telling them how much better they would

> look, they seem to stop the finger nail-biting. I believe that after a little encouragement the girls in C. W. will have nice finger nails. (B. S.)
>
> They bite their nails only when excited. I showed them my nails as I used to bite my own nails, and it seemed to work in keeping them from biting theirs. (M.)
>
> She stopped biting them because she intends to have nice nails. The only time she bit her nails was when she became nervous.
>
> Olive oil was applied three times daily to soften the cuticle, give nourishment to the nails, and prevent brittle nails. The olive oil, in a way, prevented her from biting her finger nails. (M. W.)

From the patients' testimonies it was found that nail-biting usually occurred as an aftermath of fights with other children.

Sex possibly contributes to nail-biting, in proportion, as it constitutes the individual's problem (anxiety). It occurs frequently in the case histories.

The amelioration of these cases seems to be, primarily, a problem of motivation. Under the existing conditions, nail-biting fulfills a need.

The physician in charge of the children's ward, Max Rosman, claims that "as the patient's problem was successfully solved, the finger nail-biting discontinued." It appears that nail-biting is a segment of behavior which is displayed when a problem situation, the kind oftimes described as worry, exists over a period of time. Whenever the individual is not actively engaged in overt behavior the tension increases and nail-biting ensues. Nail-biting seems to be a concomitant of this persistent emotional tension.

Question six, in the data, was asked in order to validate the veracity of the patients' answers. Nail-biting being essentially an activity which occurs while the individual is under tension, and sleep being primarily an activity which requires the organism to be in a state of relaxation; an affirmative answer would seem to appear fallacious. However, this means of validating the veracity of the patients may not hold completely. Since only three of the cases answered in the affirmative one might suspect that the word "sleep" was accepted by these patients as synonymous with "going to bed." That they may have interpreted it in this manner is borne out by one of the nurses who told of one of these patients biting her nails after being in bed. Here the nail-biting behavior may have been the result of anger or resentment at having to go to bed.

The fact that these children were committed to a State hospital implies that they were behavior problems at home.

The behavior of these children, as observed during interviews, did not appear to differ from the so-called normal child in kind, but rather in degree.

5. *Findings*

The patient having the highest *IQ* among the nail-biters responded quickly to the treatment, completely stopping biting activity. The lowest *IQ*'s showed negligible or no improvement. Those in the middle range showed a limited improvement.

Finger nail-biting was a segment of behavior found in the children's ward among unstable, irritable, upset, impulsive, and restless children.

Most conspicuous among the patients studied was a state of tension and a high degree of activity.

Most of the patients were not aware of the act of biting their finger nails.

Nail-biting in many cases could be traced to mothers, or relatives with whom they had come in contact.

The patients very seldom bit their nails while occupied with their favorite activity, in occupational therapy.

F. SECTION *F* (1937-38)

1. *Problem*

To find the incidence of finger nail-biting; to determine what facts are generally believed true of nail-biters; and, to determine which of the basic conditions are most responsible in eliciting this behavior.

2. *Procedure*

The incidence of nail-biting was determined during December, 1937, by inspection of the pupils' fingers, verification by the pupil, and observation of its occurrence during the class period.

During April, 1938, 60 tenth grade girls were asked to enumerate on sheets of paper three facts which they believed to be true, especially, of nail-biters. This group consisted of 50 non nail-biters, and 10 nail-biters.

During May, 1938, the nail-biters were asked to choose which of these four activities: (*a*) delay in time between stimulus and response (suspense); (*b*) making discrimination too subtle; (*c*) overstraining; (*d*) or two opposite activities (as something very pleasant and very disagreeable) at the same time, were most conducive in eliciting nail-biting behavior. The responses were written on slips of paper, then they were collected for tabulation.

Several pupils were interviewed in respect to what they meant by the term "nervousness."

3. *Data*

Of the 130 tenth grade students studied, 114 were girls and 16 boys. It was found that 26 of the 130 pupils were nail-biters; or 20 per cent.

The facts believed to be true of nail-biters, according to 60 tenth grade girls, are ranked according to frequency in Table 17. Those facts which occurred only one time are not recorded in the table.

TABLE 17

REPORTED FACTS BELIEVED CONCERNING NAIL-BITERS: Girls

Believed facts	Frequency
They are nervous	42
They are excited	24
It is a habit	20
They are hungry	13
It occurs when one is idle	10
They do it because of fear	9
Because they are worried	8
They are unaware of doing it	6
They are not healthy	6
They are high-tempered	5
They enjoy it	4
They do it when they are thinking	4
They are irritable	3
They lack control of their feelings	2
It is due to conditions in the home	2
Because they cannot chew gum	2
They do not eat much	2

A few of the facts mentioned only once but which seemed to be of some importance are:

> That is the only way of quieting their nerves, they do not know what else to do.

They always talk and won't give anyone else a chance to talk, they like to argue about something.

It is unhealthy.

It takes the place of doodling.

The choices made by the nail-biters of the four "prepotent stimulus situations" are listed in Table 18.

TABLE 18
PREPOTENT STIMULUS SITUATIONS ELICITING NAIL-BITING: Both Sexes

Stimulus situation		Frequency
Suspense		19
Discrimination too subtle		2
Overstraining		2
Two opposite activities		3
	Total	26

4. *Discussion*

Since the majority of cases available were girls, both sexes were combined.

The facts believed to be true concerning nail-biters, as evidenced by those who were nail-biters at the time and the non nail-biters are worth more than passing notice. The facts presented by the 10 nail-biters as compared with the 50 non nail-biters were identical. Each of them stressed the importance of "nervousness." Many pupils appeared actually to believe that this was really the cause. They did not realize that the term "nervousness" is a descriptive term and could not possibly be the causal factor. During interviews with a few of these students who claimed nail-biting was due to nervousness, when asked to elucidate they very frequently insisted that anybody knew what "nervousness" was. In these interviews the pupils were asked to explain further what this "nervousness" was. They would usually say, *"I cannot explain, I am just nervous, I was always this way."* If one pressed the point they would become indignant. They seemed definitely to resent being questioned. Another fact, "it occurs when one is idle," was found to mean that they were unable to do what they wished. In this kind of a situation they were usually comparing what they were doing with what they would have liked to be doing. In these situations the things they were required to do were done automatically and to them this did not really seem to be "doing." Only doing what they would like to do would be "real doing." The "excitement" cited by the pupils seems to be of two origins: (*a*) being teased (anger), or (*b*) a perceived crisis (fear).

The "prepotent stimulus situations" were suggested by Razran. He was of the opinion that "two opposite activities" was the most prepotent stimulus situation in activating nail-biting behavior. However, the information obtained, and reported in Table 18, indicates that "suspense," or delay between stimulus and response, was the most prepotent. There possibly is a certain degree of specificity indicated in this table that would not hold for other ages as these pupils were adolescents, and most of them were girls.

5. *Findings*

Of the 130 pupils studied, 20 per cent were nail-biters.

Nail-biters did not indicate any greater insight into their behavior than did the non-nail biters, in respect to finger nail-biting.

The most frequent fact cited by the pupils was the belief that "nervousness" was the basic cause of finger nail-biting. The next in importance was "excitement," with "habit" ranking third.

The most prepotent stimulus situation, for tenth grade girls, was one in which suspense occurs.

G. SECTION *G* (1938-39)

1. *Problem*

The aspects considered were: the incidence and duration of finger nail-biting; and an attempt to find what methods, if any, had been used in trying to curb this behavior.

2. *Procedure*

The incidence was determined by inspection of the pupils' fingers, verification by the pupils, and observation of the pupils during class periods.

To ascertain the duration of nail-biting; to find whether anything had been done to try to ameliorate this behavior; and to learn what methods were used, a questionnaire was employed. The 33 nail-biters were given sheets of paper which contained five questions.

They were directed to write their responses to these questions, and after they felt satisfied that they had answered them to the best of their knowledge they were to return the papers.

3. *Data*

Of the 132 tenth grade girls met during April, 1939, 33 were nail-biters; or 25 per cent.

The questions submitted to the 33 nail-biters, to be answered, were:

1. Present age.
2. How many years have you been biting your finger nails?
3. Has anyone, including yourself, ever tried to stop this behavior?
4. What method was used?
5. Under what conditions do you usually bite your nails?

By subtracting the number of years each had indulged from her present age the probable incipiency of the nail-biting behavior was determined. This is reported in Table 19.

TABLE 19
PROBABLE AGE OF INCIPIENCY OF NAIL-BITING

Age started	Frequency
4	1
5	4
6	0
7	2
8	5
9	10
10	6
11	2
12	1
13	2

Among the 33 nail-biters, 30 reported that either they themselves, or others had attempted one or more times to curb this behavior. This indicates that of the cases studied 90 per cent had at some time or another been subjected to some therapeutic technique.

The most frequent methods cited are: binding the fingers with adhesive tape, being slapped on the hand, making them ashamed of their bitten nails, using bright nail-polish, inculcating a fear of blood poison or some disease, being paid to stop, and putting iodine on the nails.

The conditions under which nail-biting occurs can be summarized as fear provoking situations, or exciting situations.

Three of the students' elaborations as to the conditions under which nail-biting occurs, and their attempts at curbing this behavior, are given:

> *Helen, IQ—97, age—15.*
>
> I just stopped biting my fingernails because I thought of how some girls had nice nails and I always looked at mine to compare and I'd think of what an ugly thing it was to do at my age. I'd bite them over excitement, but at present there are many things to do instead of biting nails.
>
> *Evelyn, IQ—124, age—14.*
>
> I stopped biting my nails three days ago. I had been biting them for almost two years. Most of the methods I used failed, such as painting the nails with iodine, etc., so finally I painted them with the brightest nail-polish I could buy. That cured me.
>
> *May, IQ—120, age—15.*
>
> I made a New Year's resolution not to bite my nails, but from force of habit I do it unconsciously. I do it mostly when I am excited, or scared. Frequently in the movies. I've tried putting adhesive tape around the finger nails I bite the most, and also putting thick, brilliant nail-polish on. I did not bite them then because I did not like the taste, but when the nail-polish came off I bit them again.

4. *Discussion*

The reliability of the students' reports as to the duration of nail-biting is doubtful. However, in Table 19 there is a detectable trend as to its incipiency. There is a slight concentration at five years of age, and a large concentration at nine years of age. Between the ages of eight and ten, inclusive, 62 per cent of the cases studied had their incipiency.

5. *Findings*

Of the 132 tenth grade girls studied 33 were nail-biters, or 25 per cent.

The majority started biting their nails between the ages of eight and ten years, according to their reports.

They report that nail-biting occurs while they are excited or scared.

In 90 per cent of the cases at least one attempt had been made to ameliorate this condition. The most frequent methods used to curb this behavior were: taping the fingers with adhesive tape, being made to feel ashamed of this behavior, having their hands slapped, fearing blood poison or disease, being paid to stop, and putting iodine or finger nail-polish on the finger nails.

H. SECTION *H* (1939-40)

1. *Problem*

To find the characteristics of pupils in these three classifications: nail-biters, former nail-biters, and non nail-biters; according to intelligence, neuroticism, disciplinary infractions, and attitude toward their school. To find the tenth grade pupils' conception of the incipiency, incidence, and amelioration of finger nail-biting.

2. *Procedure*

From September to December, 1939, each time a pupil committed an offense during class period as chewing gum, making unnecessary noise, or talking to his neighbors, the incident, pupil's name, class in which it occurred, and the amount deductible from the pupil's conduct mark were put on 3 x 5 filing cards. These cards were filed chronologically.

There were 12 classes of pupils in the Hunsicker Annex. Six of these were met by Oswell J. Seip, and the remainder by the writer. During the first week of January, 1940, the incidence of nail-biting was ascertained for each of these classes in the following manner. In each class a sheet of paper was circulated bearing the headings: nail-biter, former nail-biter, and non nail-biter. The pupils were instructed to sign their names in the appropriate column. Those pupils who had never indulged in nail-biting throughout their life were to sign their name in the column headed non nail-biters. Those who had bitten their nails at some time in their life, but had stopped prior to this tabulation, were to sign in the column headed former nail-biters. Those who were active nail-biters at the time were requested to sign their names under the heading nail-biter. Prior to this classification the pupils were informed that the collection of this data was for the purpose of research. When in doubt as to a particular pupil's status it was checked by inspection of the pupil's fingers, or by direct observation. As a whole, the pupils proved to be quite truthful. This data, in conjunction with that found in the school records, was tabulated and classified so that it could be summarized in tabular form. The intelligence quotients entered in the school records were derived from the Binet-Simon tests.

About this time the accumulated cards which had been collected, pertaining to the disciplinary infractions, were sorted into three categories: Nail-biters, former nail-biters, and non nail-biters.

On January 30, 1940, each pupil in the 12 classes was given a copy of the Bernreuter *Personality Inventory,*[1] and the Bell *School Inventory.*[2] A class period, 50 minutes in length, was allotted for filling out these forms. The pupils who were absent when these tests were given received them within the next school week. After all the forms of both tests were scored the results were tabulated on ledger sheets. The information appearing on these sheets, for each pupil, consisted of name, age, *IQ*, raw score of the *B*1-*N* scale of the Bernreuter test, this score's percentile rank, the Bell score, and which quintile this score fell. Whether the person in question was a nail-biter, former nail-biter, or non nail-biter also appeared on this sheet.

The three classifications: nail-biters, former nail-biters, and non nail-biters, each containing one hundred cases were matched according to sex; *IQ,* within plus and minus five points; and age, within the same year.

The mean *IQ* (ungrouped) was determined for all the cases falling within these three classifications, together with their respective ranges.

During April, 1940, the pupils in six of the classes were informed that they would have one month in which to write an account on the topic: *The causes, occurrence, and cure of finger nail-biting.* This account was mandatory. They were further instructed that the account should contain from 200 to 500 words.

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[1] Robert G. Bernreuter, *The Personality Inventory.* California: Stanford Univ. Press, 1935.

[2] Hugh M. Bell, *The School Inventory.* California: Stanford University Press, 1936.

3. *Data*

All cases studied in this section came from the Hunsicker Annex of the Allentown High School. They consisted of tenth grade pupils of both sexes. These pupils were divided into two equivalent groups; one group consisting of the six classes met by Oswell J. Seip, and the other group the six classes met by the writer. The pupils in these two groups were separated into three classifications, namely: (*a*) non nail-biters, meaning (in this study) those pupils who had never bitten their nails; (*b*) former nail-biters, those who had indulged at some period of their life, but who had desisted prior to this investigation; and (*c*) nail-biters, those pupils engaged in nail-biting activity at the time of this investigation. To facilitate understanding the distribution of pupils composing the two groups in these three classifications Tables 20 and 21 were constructed.

TABLE 20

THE DISTRIBUTION OF CASES IN THE FIRST GROUP

Period		N.-B.	Former	Non	Total	Per cent N.-B.	Per cent of N.-B. and former N-B.
(G)*	I	10	8	10	28	35.7	64.3
(M)	II	13	9	10	32	40.6	68.8
(M)	III	13	8	9	30	43.3	70.0
(M)	IV	13	6	11	30	43.3	63.3
(M)	V	2	14	15	31	6.5	51.6
(G)	VI	6	17	9	32	18.8	71.9
Total		57	62	64	183	31.2	65.0

*(G) All girls; (M) Mixed; (B) All boys. These abbreviations also apply for Table 21.

TABLE 21

THE DISTRIBUTION OF CASES IN THE SECOND GROUP

Period		N.-B.	Former	Non	Total	Per cent N.-B.	Per cent of N.-B. and former N-B.
(B)	I	9	12	12	33	27.3	63.6
(G)	II	9	12	11	32	28.1	65.6
(B)	III	4	13	13	30	13.3	56.7
(G)	IV	8	13	8	29	28.6	72.4
(G)	V	20	6	8	34	58.8	76.5
(G)	VI	2	18	10	30	6.7	66.7
Total		52	74	62	188	27.7	67.0

Summarization of the material in the preceding tables is made in Table 22. This table also includes the "probable error" of the percentages.

TABLE 22

DISTRIBUTION OF CASES IN THE TWO GROUPS

Group	N.-B.	Former	Non	Total
1	57	62	64	183
2	52	74	62	188
Total	109	136	126	371
Per cent	29.4	36.7	34.0	100.
σp	.044	.041	.042	.00

The number of cases used in the next tabulation (Table 23) is less than the original number. This is due to the fact that some of the pupils were transfers from other systems. In checking the school records it was found that some of these pupils' intelligence quotients were derived from other sources than the Binet-Simon tests (Stanford Revision, 1916). Others had no *IQ* listed on their school record. Thirty-seven cases were eliminated for these reasons. The number of cases considered satisfactory was 334.

The manner in which the intelligence quotients distribute themselves in the three classifications (nail-biters, former nail-biters, non nail-biters) is listed in Table 23. Since the total number of cases was quite limited, 10 was chosen as the most appropriate interval.

TABLE 23

A FREQUENCY DISTRIBUTION OF INTELLIGENCE QUOTIENTS FOR NAIL-BITERS, FORMER NAIL-BITERS, AND NON NAIL-BITERS: Both Sexes

Range *IQ*	Nail-biters.	Former N.-B.	Non N.-B.	Total
140-149	1	2	0	3
130-139	0	1	1	2
120-129	4	11	5	20
110-119	11	22	21	54
100-109	23	41	30	94
90-99	38	30	31	99
80-89	17	10	18	45
70-79	7	3	7	17
Total	101	120	113	334

As each of the classifications was of different size, the numerical frequencies were not directly comparable. By converting the cases occurring in each interval into percentages the values in the various intervals became more comprehensible. To this end Table 24 was computed. This table also makes more noticeable the relative distribution in each interval.

TABLE 24

A Percentile Distribution of Intelligence Quotients: Both Sexes

Range *IQ*	Nail-biters	Former N.-B.	Non N.-B.	Total
140-149	.99	1.67	.00	.90
130-139	.00	.83	.88	.60
120-129	3.96	9.17	4.42	5.99
110-119	10.89	18.33	18.58	16.17
100-109	22.77	34.17	26.55	28.14
90-99	37.62	25.00	27.43	29.64
80-89	16.83	8.33	15.93	13.47
70-79	6.93	2.50	6.19	5.09
No. of cases	101	120	113	334

For each classification, nail-biters, former nail-biters, and non nail-biters, the mean was computed (ungrouped) together with their respective ranges. These facts are found in Table 25.

TABLE 25

The Mean *IQ* and Ranges of the Nail-Biters, Former Nail-Biters, and Non Nail-Biters: Both Sexes

	Nail-biters	Former N. B.	Non N. B.	Total
No. of cases	101	120	113	334
Mean *IQ*	97.76	103.51	99.94	100.83
Highest *IQ*	140	143	135	143
Lowest *IQ*	70	76	73	70

When the mean *IQ* was computed for all those who were not biting their nails, the former and non nail-biters, at the time of this investigation it was found to be 102.19, whereas the present nail-biters' mean *IQ* was 97.76.

For intensive work 100 cases were chosen from each of the three classifications, nail-biters, former nail-biters, and non nail-biters. Elimination of cases depended on their being, or not being, able to be matched to a comparable case in each of the other classifications. The nail-biting group was chosen as the master group. The criteria for matching was age, sex, and *IQ* (within plus and minus five points). The case falling in the 140-149 *IQ* interval was dropped, since there was no comparable case in the non nail-biting group. It is of interest to note that a nail-biter, a girl, had a neurotic score equivalent to the ninety-ninth percentile on the Bernreuter *Personality Inventory*, indicating her to be definitely neurotic.

The distributions of the three classifications are grouped in deciles. As there are 100 cases in each classification they can be thought of as per cent. Therefore, the numerical frequency in each decile is the percentage within this interval.

TABLE 26

CASES IN THE VARIOUS DECILES

Decile	Nail-biters	Former N.-B.	Non N.-B.
90-99	7	5	7
80-89	13	5	3
70-79	12	9	10
60-69	22	7	15
50-59	10	5	12
40-49	10	17	10
30-39	7	15	12
20-29	13	15	7
10-19	4	7	10
0-9	2	15	14

Among the nail-biters, 64 per cent were above the fiftieth percentile. Only 31 per cent of the former nail-biters exceeded the fiftieth percentile. The non nail-biters had 47 per cent above the fiftieth percentile. In other words, the non nail-biters were apparently normal, since the discrepancy of three per cent is not significant.

The tabulation of disciplinary infractions is presented in Table 27. During the first month 80 per cent of the infractions occurred in

TABLE 27

DISCIPLINARY INFRACTIONS

Two week intervals	Nail-biters	Former N.-B.	Non N.-B.
0-2	4	0	1
2-4	12	1	2
4-6	5	2	2
6-8	4	4	3
Total	25	7	8
Per cent	62.5	17.5	20

the nail-biting category. In the second month the percentage decreased.

The relative adjustments for the three classifications, in respect to school, as measured by the Bell *School Inventory* are indicated in Table 28.

TABLE 28

STUDENTS' ADJUSTMENT TO THE SCHOOL

Classifications	*Cases having raw scores of ten or more*	Number of cases	Rank
Nail-biters	53	100	1
Former nail-biters	56	100	2
Non nail-biters	62	100	3

The score of 10 was chosen as the cut-off since this score seemed to discriminate among the three classifications. The numerical scores are probably not significant, although their relative rank is suggestive. Nail-biters tend to conform most readily, whereas the non nail-biters appear to conform least readily.

According to Guthrie:

> We are generally fairly safe in judging an individual's future by his past. . . . But this fairly easy and certain prediction on the basis of past record is of no use when the question is asked, "What can be done to change this person, to rid him of an annoying habit or of a distressing attitude?" His past now gives no information because it has no record of his behavior under altered conditions. Only the observation of other persons who have been subjected to some form of interference will answer this question (21).

Holding to this assumption, sophomore students were requested to write accounts in which they presented their experiences with finger nail-biting; together with their interpretation as to causes, persistence, and observed or believed cures. These students were instructed to observe the occurrence of nail-biting in their social environment, for the period of one month. If they themselves were nail-biters they were to observe the conditions under which they indulged in this habit. The entire group was told to try and recall any past experience they may have had pertinent to nail-biting, and also to ask their parents for further information. At the end of this month of collecting pertinent material they wrote their account. The following represents relevant material from these accounts.

Joseph, former nail-biter, male, IQ 128, age 15.

The causes of finger nail-biting, in my opinion, are nervousness and force of habit. A person, when he is nervous, must find something to occupy or gratify his desire for movement. He may also bite his nails at certain times such as while at the movies, playing ball, or while indulging in other activities. There are persons I know who bite their nails while trying to figure something out; while thinking or concentrating deeply.

I, being a nail-biter once myself, found out that the way to cure finger-nail-biting is to stop participating in activities which caused me to do so or give me the impulse to bite them. My mother, when she would catch me biting them when I was smaller, would slap or hit me. This only caused me to bite them more because it made me sort of challenge her. She often put something on my nails to try and make me stop biting them, but it would make me bite them more after the taste was gone. My mother finally stopped trying to cure me; so I found out I only bit them at certain times. I stopped doing these things and automatically I stopped biting my nails.

Russel, former nail-biter, male, IQ 105, age 15.

Nail-biting is caused through inheritance, nervousness, or loneliness. As a former nail-biter I have learned that only during idle and lonely hours the habitual pastime takes place. Often it occurs in such a manner as to cause severe nervousness. . . . .

In my opinion, as a nail-biting cure I could find nothing better than a severe corporal punishment by a parent. Several weeks of deprived recreation would cause the habit to decrease and slowly but surely the habit of nail-biting would be broken.

Gerald, former nail-biter, male, IQ 107, age 16.

I was a finger nail-biter. I first started to bite my fingernails when I started to help my father work on the baker route, and I would give a lady the wrong change. My father would go in and make the correction for me and when he would come out he would give me a scolding and then while he was talking to me I would bite them. Some other causes of fingernail biting are: nervousness, doing it from habit and not thinking of it, and when you are mad.

When I was a finger nail-biter it usually occurred when I was scared, or after I was mad and then got worried. It often occurs when you are not thinking of it.

The way I cured myself of finger nail-biting was, one day I caught myself at it and I told my older brother that every time he saw me biting my nails he should start slamming me on the arm and after awhile my arm was so sore that I soon forgot about biting nails. Other cures are: tell somebody to remind you to cut them every week, try to catch yourself in time, look at others when they are doing it and see what the outcome is.

Thomas, non nail-biter, male, IQ 76, age 16.

I think the cause of finger nail-biting is from putting your fingers in your mouth when you were a baby. Another cause is as a result of teething. . . .

There are many ways of curing finger nail-biting. By putting something on your nails that tastes bad, but will not hurt you, putting olive oil on your nails, using adhesive tape on your nails, and many other ways. I think that the best way of curing it is by using olive oil. . . .

Joseph, nail-biter, male, IQ 107, age 15.

I bite my finger-nails not knowing that I am doing it. I think the causes are you don't know that you are doing it, nervous, and habit.

You bite your finger-nails when you don't know what to do. You also bite them to keep them clean. I bite mine to keep the dirt out.

I think a good cure for biting them is to put something on them that burns and if you bite them your mouth will get sore. Another cure is by getting poison ivy on them.

Norma, non nail-biter, female, IQ 110, age 15.

Nail-biting is a habitual way to pass the time. Many persons bite their nails when there is a calamity or confusion of some sort.

I have a girl friend who bites her finger nails quite frequently. She is nervous and gets irritable for every little nonsense. Her mother puts iodine on her finger tips and that helps quite a bit. This girl is slowly getting out of this habit because she is growing up and does not want to be embarrassed unnecessarily by biting her nails.

Claudia, nail-biter, female, IQ 93, age 15.

Finger nail-biting is a monotonous thing to do. I am at it ever since I was small. My mother and father say they believe it comes from nervousness.

It is very hard to stop it once you start it because I have tried many ways of stopping such as putting some bitter medicine on and polishing them, but it just seems I cannot stop. I think the cure might be just to let them go if possible and when someone sees you have your fingernails in your mouth they should tell you to stop or give you a slap.

Miriam, nail-biter, female, IQ 86, age 15.

I believe finger nail-biting is caused when people get nervous. When children in school are told that they are to have a test next week they start to worry about it, especially the day before they have the test, then they start biting their nails. Then the next day when they have the test they don't know much about it because while they were trying to study the night before they couldn't, because the nail-biting took up their time and took their mind off their work.

I got the idea of biting my nails by seeing one of my friends do it. I thought it was pretty clever, so I adopted it too.

I bite my nails especially when we have a test and I don't know much about it. I also bite my nails in classes that I don't care much for.

I think the cure for girls who bite their nails is to wear artificial finger nails.

Catherine, former nail-biter, female, IQ 115, age 15.

I think nail-biting starts from the nerves. As for myself, when I got nervous, or in a rush, I put my fingers to my mouth, and before I knew it I had a few finger nails off.

One day one of my friends called to take me for a walk, . . . my friend looked at my fingers and I knew what was going to happen, before I could make an excuse he asked me if I bit my nails. I could not say no, . . . so since that time I never bit my nails.

Anna, nail-biter, female, IQ 96, age 15.

I first began to bite my nails at eight or nine years of age. My nails, at that time, interfered with my marble playing so I bit them off. This continued until it was a habit I could no longer control. Every time I concentrated my hands unconsciously came to my mouth. . . . I tried many different ways of stopping but to no avail. Then I noticed that only when I concentrated my fingers were in my mouth. My remedy was to chew gum, so instead of taking it out on my fingers I would chew hard on my gum. Then came a few months of nervousness and my newly acquired nails went with it. Everything I tried would fail, even the gum. I tried very bright nail-polish, iodine, and sulphur. Then as quickly as it came, my nervousness stopped and with this change I stopped biting my nails without even trying, but it seems that I had to twiddle with something while I concentrated or read. Now I have the very bad habit of biting all the skin on top and around my nails until they bleed. I have not conquered this habit yet, and I know not how.

Geraldine, former nail-biter, female, IQ 124, age 15.

Nail-biting is nothing more than habit, and anyone who is determined to break the habit can do so. At one time I was biting my nails, but one day a friend noticed it and I was embarrassed. That day I determined to stop, and I did. I don't believe there are any really serious conditions for biting nails other than what the person believes in their own mind.

Betty, non nail-biter, female, IQ 105, age 14.

Probably the chief reason for finger nail-biting is habit.

Finger nail-biting usually occurs when a person's nerves are high tensioned, or when he is bored by the person or subject which he is currently subjected to. Motion pictures give the person the time and the excitement needed to bite his nails. Reading a novel, especially a mystery story, gives the person ample opportunity to indulge in this favorite pastime. . . . A small child should have a companion in a large empty house, or he too will become frightened by strange noises and turn to his finger nails for comfort.

This defect can dampen a person's morale and therefore should readily be looked after. There are a few suggestions by which to cure this, such as putting warmed olive oil at the end of the cuticle. White gloves also are a means toward the cure. But the most helpful cure is the person himself, by his own will-power.

Betty, nail-biter, female, IQ 91, age 16.

The most important cause of finger nail-biting, I believe, is when you are upset and nervous about one reason or another; you bite your finger nails to get your mind off of your trouble. I have bitten my finger nails because I have seen other people doing it. Frequently people that are idle and have nothing in particular to do, bite them. Many people bite them out of habit. Occasionally people bite them because they have a feeling that they must bite them, they just can't do without it, they feel all out of place and not like themself.

I always bite my finger nails when I am annoyed by something, for some reason or other. Sometimes I bite my finger nails when I am surprised; I bite them for joy and happiness. Frequently I bite them when they bother me, at certain types of work, or when we get tests in school, especially the subjects I am not good in. I bite them when I have nothing in particular to do. When I am irritated and nervous about some news about my friends I bite them, thinking it will cheer me up. Sometimes, when I am not feeling very well, I bite them because everything annoys me then.

I think the best way to get rid of the habit is making up your mind not to do it, for success begins with a person's will. If you think you want to bite your finger nails get something to do which you enjoy, or take a walk. By keeping yourself busy with efficient work will help to decrease the nail-biting. In leisure time, find a hobby in which you are interested, this will give you less time to bite your finger nails.

Grace, former nail-biter, female, IQ 102, age 15.

One of the possible causes of nail-biting is excitement and irritation of the nail-biter. It is likely to appear also if a nail-biter is very nervous. Frequently people who worry over their affairs or events are liable to bite their nails as a means of escape, or for peace of mind.

When excitement or an eventful incident has happened or is happening one may seek to bite one's nails for self-control. Nervous persons are very apt to bite their nails because the nervous condition induces excess irritation and they bite their finger nails without any knowledge of doing so.

A probable cure for nail-biters is to obtain a substance which is bitter-tasting, to spread over the nails, then when the biter embarks on the task of chewing his nails he is met with a bitter object. This treatment was given to me at an early age and has cured me of biting my nails. Another cure is to put scotch tape or any other kind of tape around the fingers.

Eleanor, former nail-biter, female, IQ 143, age 14.

I first got into the habit of biting my finger-nails when I saw a friend doing it. Afterward it became a habit with me. Other causes for biting the nails are: worrying, nervousness, and uneven or rough nails. Some people do it unconsciously. If they do not have anything to do or are sitting idle they automatically start biting their finger-nails.

There are many so-called cures for this habit, but few of them are effective. If a person leads a quiet life he may sometimes stop biting his nails. To cure myself of the habit I bought a strong but harmless solution and applied it to my finger-nails. But this didn't stop me, and I gradually came to like the taste of the solution. What really cured me was embarrassment. Whenever I went out people always used to look at my short finger-nails and make remarks about them. After a few of these incidents I forced myself to stop biting my nails.

Margaret, non nail-biter, female, IQ 83, age 16.

The causes of nail-biting are nervousness or excitement. This habit starts chiefly when they are small, and naturally grows with the person if they are not conscious of it. Usually this happens when they have leisure time. If a person is jittery they also start biting their nails. The possible cure for this is to polish the nails; or to inspire the person to take care of their nails. If this doesn't help, artificial nails can be put on, this way when they start biting the artificial nails do not break off and the person might forget about biting their nails.

Stephen, non nail-biter, male, IQ 106, age 15.

A few causes of finger nail-biting, I believe, are: when a person is nervous he immediately puts his hands to his lips and without knowledge of what he is doing he chews his nails; another cause is a force of habit, a person who bites his finger-nails just so he can do something to steady his nerves; another time I've noticed that a person purposely bites his nails to annoy somebody; many persons bite their finger-nails because they are long and annoy them. When a person is worried he also bites his finger-nails.

The cures for finger nail-biting are: cut off the finger-nails until the person forgets about them. I cured my brother of this habit by embarrassing him in front of his companions and a few times in front of girls. I know a lady who mixes some harmless ingredients and when her children are asleep she puts it under their finger nails. When they bit their nails they immediately started to spit and the mother told them that a little boy got sick from the germs on his finger-nails. The children looked frightened a bit, but I have seen that they have nice even finger-nails, instead of the kind they had a few weeks before. In some cases the children who have their hands slapped when they chew their finger-nails stop the habit, because they are afraid of being reprimanded. Some children, when reprimanded, become spiteful and do it to anger their parents.

Lamar, nail-biter, male, IQ 95, age 14.

As a nail-biter I should say the causes for nail-biting are nervousness or an unsafe feeling. During an exciting or horrifying motion picture, or riding in a speeding automobile, one's fingers tend to draw toward the mouth and nail-biting occurs.

From my own experience, I remember riding in an automobile at a high rate of speed and in a few seconds I found myself biting my finger-nails. Another incident I can remember was the ninth grade examinations, which had me worried and nervous. A few minutes before the examinations began, almost automatically my hand was drawn to my mouth and nail-biting began.

Personally, I do not think nail-biting in an adult can be stopped by putting iodine or other drugs on them. Although small children may be cured by applying a harmless, harsh-tasting drug. The best cure, I think, would be force of will-power. Every time you start to bite them think of the danger to your body and appearance and there might be a possibility that the person will stop.

Stanley, non nail-biter, male, IQ 105, age 15.

A person who is nervous usually bites his nails. Some people bite them when they are alone and have nothing to do. I also believe that finger nail-biting runs in the family. As in my own case, my father and mother did not bite their nails and the same applies to me. Another cause comes from leaving children who bite their nails go near small children or babies, the small children will see them doing it and will imitate them. After they imitate them, it will become a habit.

It usually happens when the victim has nothing to do and becomes nervous, so he bites his nails to give him something to do. It also happens when a person is under a strain, as when someone is questioning him. A person should never be told to stop because as soon as the person's back is turned he will do it again just for spite.

They should use more effective means of trying to make them stop, like putting a liquid on the nails that is disagreeable to the taste; or file the nails down so they cannot bite them and keeping them filed down until he is broken of the habit. A pleasanter way would be to give him something to do, like building model airplanes, to keep his mind off his nails.

Carl, former nail-biter, male, IQ 91, age 15.

The only cause for biting my nails was that I, when younger, was very nervous, and very much afraid. In my third year of school my arithmetic teacher was very hot headed, and had an awful temper. From that year, until about two months ago, I was biting my finger-nails. For the past number of years I have tried a few different ways of stopping, but met with little success.

I usually bit my nails when in a very nervous state as when taking a test in school, while listening to an exciting radio program, very often at home while playing a game of chase, sometimes while waiting for my boy friend. Now that I am older I have lost a lot of that fear and nervousness, which I believe has helped greatly in the cure of my nail-biting. My buddy and I, both used to bite our nails, but after you started this experiment we made an agreement that whenever we see the other one biting his nails we would slap the other fellow's hand. This little trick, and some personal pride have all helped in my stopping of finger nail-biting.

Roland, non nail-biter, male, IQ 103, age 15.

I have observed that when a friend of mine bites his finger-nails he seems extremely nervous. He doesn't bite them constantly but only, it seems, when he gets the notion or urge.

He bites his finger-nails almost every time he sits by the radio. It may be excitement, nervousness, or just a lack of something else to do. When he visits me, or another of his friends, and if sitting and talking quietly, he begins biting his finger-nails, if that is what you can call those things on the end of his fingers. He has them chewed down to mere blotches. He owns a guitar but doesn't play it much because of his finger-nails not being able to support his fingers when he presses on the strings. Thus he is always complaining.

I believe the thing, or things, that will cure him are trying to play more on the guitar, as there is a need for finger-nails of the correct length and shape. Then, he should concentrate on keeping his hands away from his mouth while sitting by the radio. If he could have a chain with a few keys on the end, to swing; this would keep his hands busy. In other words he should have some means of diversion. If he has to be nervous let him show it by swinging the chain and not by biting his nails. Last, or perhaps first, he should improve his nervous condition.

Thelma, former nail-biter, female, IQ 99, age 15.

The people of today who bite their finger-nails are usually considered nervous. They are very annoying to the people around them. Many people have various ideas as to the causes of finger nail-biting, but the one occupied *in this task is really the only one who knows. . . .*

If you have ever watched a finger nail-biter as he goes about his task, you will probably note that he has several ways of approaching his nails, and probably does it unconscious of the fact until he feels it. He probably first leans on his elbow, then rests his head on his hand, and finally places his fingers in his mouth and chews away to his heart's content.

Putting various things on the nails, wearing gloves, having someone slap you each time you place your fingers in your mouth, and various other ways have been used to cure it, but few have had success. The person himself must just set his mind to it, and have a good reason not to bite them, and after a time they will break away from the habit.

I used to bite my finger nails but have stopped for about two months now.

I did most of my biting when I attended movies or if I had something on my mind. The one thing that made me bite my nails most was worrying about my marks at school. A way that helped me to stop biting my nails was, as soon as I got home from school I chewed gum, and as long as I had something in my mouth I didn't bite my nails.

Mary, former nail-biter, female, IQ 121, age 15.

When I see an exciting gangster or mystery picture, or read an interesting book I always have to have something to chew on. If I have candy or chewing gum my nails are safe. If my nail breaks and becomes rough, and there is no finger nail-file near by, it bothers me so I start biting it.

I can sometimes leave them grow for a period of time, but then I bite them again. Just now I am leaving them grow. When I polished them they grew, but then I peeled the polish off. Therefore, I think the cause of nail-biting is nervousness.

I think manicuring the nails is about the best cure, but then it shouldn't be stopped until the nail-biter is convinced that he is cured. Another way to stop nail-biting is by putting iodine or some kind of bitter medicine, or salve on the finger tips.

Dorisceil, non nail-biter, female, IQ 113, age 16.

In my estimation, the causes of nail-biting are mainly due to just plain carelessness, or as something to pass the time. Although, in a state of emotion or excitement, a person may find this about the most natural or quickest way to quiet themselves.

A person has to start biting his finger nails, so it is up to him, and to him alone, to stop it. It is only, more or less, a habit and almost everyone, I think, who really cares to and wants to can cure themselves of their own habits.

A very good and inspiring cure for some girls is to get a glimpse of well kept finger nails, this gives them a longing for the same. So many girls, of teen age especially, have found this to be the most likeable and quickest cure for the habit.

Irma, non nail-biter, female, IQ 93, age 15.

Nail-biting is often caused by nervousness of a person, then it becomes a habit, and is very hard to get out of. People go to the movies and they see something exciting, the first thing you know is that their hand is in their mouth. Often when people walk on the street something happens and they get scared, then they bite their nails.

There are many ways to get out of biting nails, by just a little effort from the person doing it. You can put soap under the nails; iodine rubbed around the nails, bandage the fingers, pepper under the nails.

4. *Discussion*

The assumption of three classifications, nail-biters, former nail-biters, and non nail-biters, instead of the usual two was considered significant. The idea of a trichotomy was suggested by Helen Walker. Her idea was that the former nail-biters would be more similar either to the nail-biters or to the non nail-biters. It was apparent that each of these categories had some unique characteristics.

Their distributions were such that roughly each composed one-third of the experimental group. This was very fortunate as it facilitated setting up the three categories so that there would be 100 satisfactory cases in each. Another tendency definitely indicated by Tables 20 and 21 was that approximately one-half, or more, of the nail-biters had desisted by their fifteenth year of life.

One can see that there was considerable variation of the incidence within each of the categories, period to period; however, the two groups studied were considered equivalent. It was observed that those pupils who come from the lower economic levels, and from the oldest population centers of the city contributed more active nail-biters than did those coming from the higher economic levels and younger population centers of the city. About one-sixth of the cases (first group, period five; second group, period six) were from outside districts (rural section). These contributed the smallest percentage of active nail-biters. Although there had been as many nail-biters among the pupils in these periods as among the urban pupils a larger number had desisted.

The first group, Table 20, and the second group, Table 21, were considered equivalent for this investigation and were summarized in Table 22. The standard error of the percentages, of each of the categories, was also indicated in this table.

Table 23 offers an interesting distribution of intelligence among the three classifications. Of the three cases in the highest interval, 140-149, two were former nail-biters, and one an active nail-biter. All the cases having intelligence quotients that were comparable were used. Those *IQ's* which were derived from tests other than the Stanford Revision, 1916 ed., of the Binet-Simon tests were not considered comparable. Some students who were transfers from other districts did not have any *IQ* recorded on their school records. It was deemed advisable to convert the frequencies in Table 23 into percentages (Table 24) since each classification contained a different number of cases. By simple inspection the outstanding characteristics of each of the distributions can be seen. To obtain the greatest possible accuracy from the available data the means were computed (ungrouped) in Table 25. By taking all those not biting their nails at the time of this investigation (former and non) their mean *IQ* was found to be 102.19. There was found to be a detectable difference between the mean *IQ* of the nail-biters and the former nail-biters. There is also a difference between each of the three classifications. The non nail-biting group had a mean *IQ* of 99.94 which is essentially the same as the theoretical mean for intelligence at large. As a group the former nail-biters were slightly more intelligent having a mean *IQ* of 103.51. The nail-biters' mean *IQ* was 97.76. This gives a difference of 5.75 between the mean *IQ* of the former nail-biters and present nail-biters. This difference suggests that intelligence may at least facilitate the desisting of nail-biting. Individuals with higher than average intelligence possess more than average insight. These former nail-biters were apparently more successful with their respective problems than those still displaying nail-biting activity during their fifteenth year. This additional insight which the former nail-biters displayed may be a concomitant of their greater intelligence. The former nail-biters were found to have the smallest percentage of cases falling above the fiftieth percentile on the neurotic scale of the Bernreuter *Personality Inventory*. The exact per cent was 31. The nail-biting group had 64 per cent exceeding the fiftieth percentile. The non nail-biting group appears to have been the most normal of the three; as there were 47 per cent exceeding the fiftieth percentile. In one particular case, the girl having the highest *IQ* among the nail-biters, that of 143, had a neurotic score falling in the ninety-ninth percentile. Evidently in this case in spite of the superior intelligence of this pupil her problems were such that they exceeded her mental capacity, as evidenced by the high neurotic score.

Table 27 shows, rather definitely, that nail-biters are most likely to be the offenders during the first month of school. During the first month they contributed 80 per cent of the infractions, whereas during the second month their contribution was 45 per cent. If we inspect the last two-week interval we see that the nail-biters were contributing only about their expected proportion of infractions. Within the two month interval in which this investigation was conducted the nail-biters contributed 62.5 per cent of the infractions. Their higher amount of infractions may be due to the excessive drive which nail-biters appear to possess. In line with the trend of a diminishing proportion of infractions, contributed by nail-biters, was that of greater conformity to the school dictum, as evidenced by the information found in Table 28. This indicates that at the time the *School Inventory* was given the nail-biters tended to have the lowest average number of individuals having 10 or more complaints, of the three classifications. The former nail-biters were a bit more dissatisfied but were more like the nail-biters than the non nail-biters. The difference was only three per cent. It should also be noted that the former nail-biters, as a group, were the most intelligent of the three classifications and so probably experienced a lesser amount of frustration in their school work than did the non nail-biters. The nail-biters instead of complaining probably substituted nail-biting.

Some of the statements in the students' accounts deserve more than passing notice. The 25 excerpts offer much material for reflection.

5. *Findings*

Among the 371 students studied, in the tenth grade, 29.4 per cent were nail-biters; 36.7 per cent were former nail-biters; and 34 per cent never bit their nails.

When the present nail-biters were added to the former nail-biters they accounted for 66 per cent of the entire experimental group.

Urban pupils had the greatest proportion of active nail-biters.

The nail-biting pupil having the highest *IQ*, 143, had a neurotic score on the Bernreuter *Personality Inventory* falling in the ninety-ninth percentile.

As a group the former nail-biters had a mean *IQ* of 103.51, whereas the nail-biters' mean *IQ* was 97.76. Those that never bit their nails had a mean *IQ* of 99.94.

On the Bernreuter neurotic scale 64 per cent of the nail-biters, 47 per cent of the non nail-biters, and 31 per cent of the former nail-biters exceeded the fiftieth percentile.

The non nail-biters, as a group, appeared to be the most normal as to intelligence and neuroticism. The former nail-biters had a slightly better than average intelligence and were less neurotic than the non nail-biters. The nail-biters were slightly below in intelligence and were more neurotic than either of the other two categories. Of the pupils studied this was true for non nail-biters, former nail-biters, and nail-biters as a group; there were exceptions in each of the classifications.

Nail-biters contributed 80 per cent of infractions during the first month of school, 45 per cent during the second month, but only 36 per cent during the last two-week interval. For the entire period of eight weeks 62.5 per cent of the infractions were accountable to the nail-biters.

The non nail-biting group had 62 per cent of their scores exceeding 10 on the *School Inventory*, by Bell. The former nail-biters had 56 per cent, and the nail-biters 53 per cent. The nail-biters appear to be the more conforming to the school situation.

The tenth grade students' accounts contain valid and reliable evidence bearing on the problem of finger nail-biting.

The great majority of the students in their accounts expressed the belief that nail-biting could be cured, nevertheless realizing, at least in part, the difficulty encountered in curbing this behavior.

The crux of any so-called cure, no matter how scientific or bizarre, is dependent upon the attitude and belief of the person to be cured of the nail-biting behavior.

Nail-biters often become resentful when adults try to stop this behavior by taping their fingers, or putting bitter-tasting solutions on their fingers.

IV. INTERPRETATION AND DISCUSSION

In fitting into a completed mosaic the findings of an investigation covering eight consecutive years one is impressed by the slight progress made. The inductive methods were used, almost exclusively, since they appeared to be the most appropriate. Seashore, in discussing work methods characterizes the inductive methods by saying: "The inductive methods of scientific research might then be thought of as a super 'low gear' having tremendous power, but with low speed" (52). Syz, in describing the part played by an investigator, makes a statement which seems á propos: "The observer himself, the psychiatrist or investigator, also embodies this matrix of maladjustment, and thus becomes automatically and unavoidably a part of the material with which he is confronted. . . ." (61).

To furnish a suitable sub-stratum of theory other writers' contributions need to be incorporated. Those investigators' works which most nearly fit the found facts are drawn upon.

Probably, as Woodworth suggests, "Young children are rather easily conditioned, and the more so up to the age of three or four. Beyond that age conditioning becomes progressively less dependable" (75). This accounts for those cases of nail-biting which have their incipiency in the third or fourth year. As it occurs, many more cases have their incipiency after the fourth year than prior to this time. In fact the greatest incipiency of the group studied was found to be between eight and ten years of age. In the light of this fact a more comprehensive form of conditioning is needed. The more inclusive form of conditioning presented by Razran is more appropriate:

> . . . . pattern conditioning possesses a considerable number of characteristics that could by no means be predicted from the known facts of simple conditioning, and that these characteristics seem to be in some, if not very definite, way related to the properties and the arrangements of the stimuli in the patterns. Specifically, the most significant indications were: (1) Conditioning to a pattern of stimuli may be much greater than to the sum of the component stimuli of the pattern, or, even, the conditioning may be evoked only by the pattern while the components are totally ineffective (supra-summation) (46).

As to the maintenance of nail-biting behavior, in discussing the effect of frequency of reinforcement, Brogden contends that "a relatively low frequency of reinforcement will maintain the *CR* at a high response-level" (10).

In the original learning situation, as nail-biting is essentially learned, some of the factors which Mowrer has noted were evidently operative. In discussing anxiety, which is definitely a factor preceding nail-biting activity, Mowrer says:

> The present analysis of anxiety (anticipation, expectancy) and its rôle in shaping both "adaptive" and "mal-adaptive" behavior in human beings is also consistent with the growing tendency to eliminate the distinction between learning through "punishment" and learning through "reward." The earlier view was that so-called punishment "stamped out" habits and *reward "stamped" them in. This distinction now appears to* have been spurious and to have depended upon a selectivity of emphasis or interest (38).

Elsewhere, Mowrer states:

> In extreme cases, where anticipation is so highly developed that it reaches the anxiety level and, to speak loosely, "spills over" into motor channels, it can often be detected in gross behavior. The so-called "nervous" movements of human beings are taken, as a matter of course, to indicate apprehension and "worry" on the part of the person showing them (37).

The preceding quotation very aptly describes the rôle played by finger nail-biting for the nail-biter. It is essentially a habituated motor outlet. Mowrer believes this preparatory set (expectancy) has a central locus. To quote Mowrer, ". . . in the final analysis this phenomenon depends upon the assumption and maintenance of characteristic body postures and patterns of muscle tension" (39). In actual observation of the nail-biting activity it was noted that there were rather characteristic postures assumed by the nail-biter directly preceding the activity, as well as during, and somewhat directly after its cessation. In elaborating on postural tensions and conflict situations, Freeman says:

> Though it would be unwarranted to suggest that postural tensions will of themselves provide a complete description of reactions to the conflict situation, the writer is encouraged to believe that we shall return from their study better equipped to handle the baffling problems of the psychoses.
>
> It is possible *that with adequate attention to detail, not only*

> may we discover the special patterns of postural fixation which are early conditioned to unsatisfied needs and bring about their reduction by reconditioning, but also we may direct the general condition of hypo- or hyper-activity to levels most conducive to psychologically adequate behavior. Even more importantly, such analysis would open the way for the establishment of a psychiatric "plimsoll mark"—a line such as is placed upon a boat to indicate how heavily it may be loaded and yet be buoyant enough to meet the added strain of storms. . . . If we had some objective criteria of the limits of effective performance set by persistent bodily conditions and could predict the quanta of energy which constituted the safe loading point of the individual's higher nervous centers, we might steer the hypo- or hyper-reactive into more appropriate situations before rather than after breakdown had occurred. Finally, instead of having to interpret a conflict situation in terms of mental dynamisms we might operate directly upon its postural residues (17).

Among practically all the nail-biters there was found definite evidence of conflict, many times of the overt type—as with boys; and the implicit type—more noticeable among adolescent girls. Symonds very aptly describes the origin of conflicts in parent-child relationships:

> No child develops, unaided, conflicts between what he feels like doing and what he believes he ought or ought not to do. Somewhere the conflict is brought into being by parents or others, who hold standards of what is right and wrong and attempt to impose them on the child. Evidence goes to indicate that far more disturbances in personality development in children arises from lack of emotional security in parent-child relationships than from any other single factor. Every parent has both love and hate to bring his child; but in too many cases the quantity of hate is dominant, and the threat of this rejection causes grave disturbances to the child (60).

In line with this trend of thought, a study conducted by Pintner and Lev pertaining to the worries of school children shows ". . . that both sexes worry most about family and school items. Next as sources of worry come personal adequacy, social adequacy, economic problems, and health problems" (44).

Consistently, it was found that nail-biters were in an emotional state (usually unpleasant) during their indulgence. The value of the emotion as a substitutive response is presented by Tuttle:

> The overt acts which are favorable to success are not emotion; for if they are known to be adequate, no emotion occurs. . . .
>
> Emotion is a substitutive response involving both internal and overt activities, together with the feelings and sensations caused thereby, resulting from failure to make an adequate readjustment. Commonly the substitutive response follows failure to escape an unpleasant situation or achieve a more highly desired situation. . . .
>
> However, thwarting is the most significant factor in explaining the nature of typical emotional states. . . .
>
> The chronically maladjusted individual is obviously the product of a long sequence of complicated factors. . . . Once the motor behavior involved in an emotional reaction proves satisfying to the individual, the tendency to condition that form of expression is begun. There is nothing about the conditioning process that precludes the permanent conditioning of abnormal motor forms, external or internal. When such conditioning has taken place, *nothing short of reconditioning can restore the* individual to normal health and balanced adjustment (66).

Delay or suspense was found to be the most prepotent stimulus situation for eliciting nail-biting. Karn indicates that even among the infra-human animals delayed response causes disruption of activity (31).

In analyzing frustration and aggression Dollard, *et al.*, point out that:

> In many adults and even children, frustration may be followed so promptly by an apparent acceptance of the situation and readjustment thereto that one looks in vain for the relatively gross criteria ordinarily thought of as characterizing aggressive behavior . . . the occurrence of aggressive behavior always pre-supposes the existence of frustration and, contrariwise, that the existence of frustration always leads to some form of aggression. . . . (15).

Children respond to adults, as Woodworth points out:

> All persons fall for the child into one or the other of two great classes; in the one class are those who impress him as *being of superior power, who evoke his negative self-feeling,* and toward whom he is submissive and receptive; in the other class are those whose presence evoke his positive self-feeling and towards whom he is self-assertive and masterful, just

> because they fail to impress him as being superior to himself (74).

According to the evidence, male nail-biters of elementary school age were found frequently to manifest temper tantrums. They also received more than their expected share of spankings.

Being what they are, nail-biters experience thwarting and conflicts quite frequently. If in a thwarting situation a child successfully reduces his tension by nail-biting he becomes predisposed to bite his nails on other occasions when thwarting occurs.

Nail-biting satisfies Shaffer's criteria of a nonadjustive response. The evidence indicates that there is

> "a persistent visceral state, . . . is diffused motor activity and a heightened readiness for random muscular responses. The tense person chews his nails. . . . The third principal symptom . . . is a condition of worry or anxiety, which is a form of fear response" (53).

It was evident that nail-biting, in its inception, was a nonadjustive emotional response to blocked anger. On recall, however, it appeared in retrospect as a fear response. Its original stimulus seems to be an interference with the self-initiated activity of the individual, which at first resulted in overt emotional manifestation of anger. The motor aspects of the anger response became inhibited by fear of punishment, but the emotional tone persisted.

The persistence of nail-biting is due to inconsistent training. Thus it was a last resort in situations involving frustration, conflict, or suspense, serving as a means of reducing fear, and in this capacity may persist in later life as a response to annoying situations or memories. If nail-biting operates to secure a temporary escape from an unpleasant task it will be learned and employed repeatedly, as will any other form of adjustment that serves as a tension reducer. This behavior owes its existence to learning (12, 57, 53). It is usually learned when the individual is in an emotional state. All of the cases studied consistently gave evidence of tension. This is in keeping with the findings of other investigators (25, 29, 53, 56, 28, 47).

Nail-biting can apparently have its incipiency any time after the fourth year (71). In the normal elementary school population studied in this investigation it was found to have its greatest incipiency during the ninth year.

The incidence of nail-biting has been the aspect most investigated, largely because it was considered as a factor in investigating other problems such as enuresis (50), other nervous mannerisms (41), and in other clinical studies (12, 30, 7). The incidence found in this investigation varied according to years, and the nature of the group studied. During 1933-34 it was found that approximately 40 per cent of the elementary pupils studied were nail-biters. During the succeeding year, 1934-35, there were 60 per cent. During July, 1936, it was found that 25 per cent of the patients in the children's ward of the Allentown State Hospital were nail-biters. The percentage found during the school year of 1937-38 was 20 per cent; 1938-39 it was 25 per cent; and during 1939-40 it was 29 per cent.

Wechsler (71), in a study conducted to ascertain the incidence of nail-biting according to age, found an increase during the ninth year, although not quite to the same extent as was found in the present investigation. He found the greatest increase occurring during the thirteenth year. This does not hold for the present study.

Since nail-biting is an emotionalized habit, some cue of the original learning situation is the precipitating factor. Some of the prepotent stimuli for nail-biting are strain (47, 71, 36, 28), rough edge of the nails (21), frustration (36, 16). The students in naming situations eliciting nail-biting indicated those in which fear or suspense were dominant.

Two general aspects concern us at this juncture: (*a*) what uniqueness nail-biters possess in regard to intelligence, siblings, neuroticism, sex, and conformity to the school situation; (*b*) to what degree.

Intelligence: Viets (67) in her study concludes that there is no difference in *IQ* for the nail-biters and non nail-biters. As her total number of cases, consisting of 75 each of nail-biters and non nail-biters, were taken from hospital case records her inference seems doubtful. Among the elementary school children studied in this investigation a slight difference was noted. The nail-biters as a group were lower in intelligence. Among the tenth grade students studied a limited difference was found. The nail-biters as a group again reflected a somewhat lower mean *IQ*. The difference in the mean intelligence of the non nail-biting group and the nail-biters was insignificant, but in isolating the former nail-biters from the non nail-biters and present nail-biters their mean intelligence was somewhat higher than either of the latter groups. This suggests the possibility that the superior nail-biters are likely to desist earlier. This does not necessarily follow for a particular individual, merely as a tendency. Among the tenth grade students studied over 50 per cent had ceased their nail-biting activity.

Siblings: There probably is no real relationship to any particular number of siblings. The present findings are substantiated, in general, by those of Viets (67). She concludes from her data that there is no real difference as to the number of siblings that cannot be explained by "chance." The one-child family appears to contribute less in proportion than would be expected (cf., 69). The larger families tend to contribute slightly in excess of the expected number. Of course the greater number of siblings would also increase the chances of this behavior being learned. As a general thesis, nail-biting seems to be essentially distributed normally, at least in a statistical sense. The following writers (35, 48, 49, 13, 63, 20, 41, 54, 36) believe neuroticism is a definite attribute of nail-biters. This general consensus was substantiated. The degree, however, as derived from standardized questionnaires was not found to be great except for a few items and even in these there was a sex differential. It would be difficult to conceive individuals who bite their nails as being neurotic to a large degree since approximately two-thirds of a school population indulge at some time of life before the fifteenth birthday. This very fact gives weight to the concept of conceiving nail-biters as "average" (45) as they would contribute approximately two-thirds of the total data (at least statistically). Without intending to be facetious, Hollingworth, in discussing neuroticism during the course of one of his lectures, stated something substantially like this: There is something cosmic about neuroses, even to our civilization, raiment, customs, etc. At the time this declaration seemed incongruous, but later observations indicated its poignancy.

Sex: The pattern for the occurrence of nail-biting is about the same for both sexes, although the types of stimuli are somewhat different. According to the analysis of significant items for girls the problem of sex as stimuli can be operative, but this is a concomitant largely due to the nature of our culture. The hospital cases indicated that sex was at times one of the problems of the nail-biters and to this extent it would be significant. Its contribution is due more to social pressure (35) than to the sex urge itself. That it has masturbatory implications (71) is much too dramatic and moralistic to be given much credence. The evidence collected does not show such a causal nexus. *To the children they were in separate categories.*

Conformity to school situation: In the rather formal school procedure employed in commercial arithmetic class the nail-biters studied tended to conform. However, if much freedom was given they became more aggressive than the non nail-biters (cf., 67).

The three highest ranking facts believed, by the students, to be true of nail-biters were: (*a*) nervousness, the belief that nervousness is a part of the nail-biting syndrome. This is substantiated statistically (20) as well as clinically (19, 12, 6) (cf., 67). (*b*) Excitement, ranking second, is substantiated by others (63), (47); and (*c*) It is a habit (16, 11, 24, 6, 48).

Most of the elementary school children claimed they were aware of biting their nails. The tenth grade students also said they were aware of indulging although they claimed they were powerless to control or stop it. The patients in the children's ward of the Allentown State Hospital denied awareness of the act of biting. Nail-biting at times seems to be used to annoy others (64), or just to work off emotional tension (4). Other times awareness is repressed (14) and the individual is unaware (29, 55). The usual nail-biter most likely is unaware of this form of behavior at times, as most of us are of other habituated behaviors. Nevertheless, when the emotional loading increases, awareness most certainly follows.

Most nail-biters feel ashamed of this form of behavior, especially as they approach adolescence. When asked about nail-biting, girls give more overt evidence of guilt than do boys, by blushing, biting their lips, etc. Dunlap (16) developed the technique of negative practice to nullify the form of tension arising from a sense of dreadfulness, or guilt, among college students.

Almost every writer has his own "pet" cure. The facts indicate that each contains some inherent value if applied to the correct case. It can also be said that categorically none are infallible with unselected cases. The crux is the person to be cured. Only after adequate analysis, and adequate insight, can the most likely method be chosen. The particular technique is not very important—the belief, by the person to be cured, in the technique to be used and a sincere desire to actually stop is almost always the most important factor in chronic cases. In the milder cases ofttimes controlling the environment (cause the adequate stimulus to be inoperative) will curb this behavior. In specific cases the reduction of school load may help (47). Where the feeling of guilt, or the compulsiveness of this form of behavior is outstanding, negative practice will be useful (16). Negative conditioning will be found advantageous in assisting to block this habit providing the individual is made to see that it is being employed as a means of helping him to do something he would like to do—stop biting (cf., 71). When the rough edge of the nail is the only adequate stimulus, then manicuring is all that is needed (21), although this is rarely the case. When manicuring is used, it should be given judiciously or it may become incorporated as part of the nail-biting syndrome. Olive oil (27) may help, for some, with the proper "build-up." Here again the attitude of the individual is paramount. In some cases of negative conditioning the aloes, oil, etc., may be so obnoxious to the biter that it will frustrate the biting. Usually though, they become accustomed to it, or they would rather endure the discomfort than give up the satisfaction derived from indulging. A reorientation of point of view by the patient, as well as by those to whom he is responsible is necessary. A sympathetic yet firm approach will do much to build up tension-tolerance. If this cannot be done the amount of tension should be reduced below the threshold of nail-biting activity. When the predisposing causes of the maladjustment which led to the nail-biting behavior are discovered and ameliorated, then it is possible to bring the individual to a realization of the ineffectiveness of nail-biting and to substitute more satisfactory modes of adjustment. When nail-biting is a consistency reaction, the real utility of which is past, a dramatic cure may offer an attractive means of disencumbering the nail-biter without loss of self-esteem.

V. SUMMARY AND CONCLUSIONS

A. PURPOSE

To determine how, and to what extent nail-biting is related to age, sex, siblings, intelligence, fear, sense of guilt, neuroticism, conformity to a school situation, infractions, and corporal punishment. An attempt was made to find its duration, the precipitating factors, the prepotent stimuli, opportunity of learning, postures assumed while indulging, and the effect of examinations (arithmetic tests) on nail-biters. It was also of interest to ascertain whether those indulging are aware of doing so, and what facts students believe true of nail-biters. Finally, to find what contraindicants had been used on nail-biters and their results; also to evaluate some contraindicants, e.g., quassia solution and olive oil, and some indicants, e.g., insight into its inconsistency with one's definition of self, catharsis, and increasing tension-tolerance. Briefly, to find the incipiency, probable causes, correlates, incidence, and amelioration of finger nail-biting.

B. PROCEDURE

The subjects utilized are assumed to be random samples (accidental). For various specific questions it was considered desirable to reduce the total number of cases to parallel groups, to make comparison more perspicuous. In survey questions, e.g., incidence, practically all cases were utilized. It is believed that what was lost by not having larger samples was overcome by intensive study of small samples over a period of years. This tended to increase randomness. The present investigation covers the period of eight years from 1932-40. Elementary school children were studied during 1932-35. From 1935-40 tenth grade students were utilized. All of these subjects represent pupils met in regular classes during the interim. During the summer of 1936 patients in the children's ward of the Allentown State Hospital were studied.

During the progress of the investigation the following techniques were found feasible. Standardized questionnaires: Woodworth-House *Mental Hygiene Inventory;* Bernreuter, *Personality Inventory;* Bell, *School Inventory;* unstandardized original questionnaires: inspection, observation, catharsis, corporal punishment, interviews, negative conditioning, statistics, item analysis, consensus of opinion, informal discussion, olive oil treatment, students' accounts, study of case histories, and perusing school records.

C. FINDINGS

Because of the nature of the inquiry the findings are presented severally. Facts are presented in a quantitative manner where data were subject to such treatment. The clinical, or more subjective inferences have to be presented otherwise.

1. *Incipiency*

Among the 89 nail-biters studied during the 1933-34 school year, the incipiency of nail-biting showed a rise of 9 per cent during the sixth year and a drop of 17.9 per cent during the tenth year. The greatest number of cases, 25.8 per cent, had their incipiency during the ninth year. No cases were found having their incipiency before four years of age. During 1938-39, among 33 tenth grade girls, the greatest incipiency was again found to have been in the ninth year.

2. *Age*

Of 223 elementary school children (both sexes) studied during 1933-34, the nine-year-old pupils contributed the highest percentage of nail-biters, 44.4 per cent, for any age-group. However, nail-biters were found in every age-group studied.

3. *Incidence*

Among 132 elementary boys studied during 1932-33, 38 per cent were nail-biters. During 1933-34, among 223 children of both sexes, 36.3 per cent of the boys and 41.1 per cent of the girls, or 39.9 per cent of the total number were nail-biters. During 1934-35, of 212 cases, 127, or 59.9 per cent were nail-biters. The girls contributed 60 per cent, and the boys 58.8 per cent. Approximately 25 per cent of the patients in the children's ward of the Allentown State Hospital were indulgers (1936). During 1937-38, among 130 tenth grade students, 114 girls and 16 boys, it was found that 20 per cent were nail-biters. In 1938-39, among 132 tenth grade girls, 33 cases, or 25 per cent were found. In 1939-40, 371 tenth grade students were studied. It was found that 29.4 per cent were nail-biters, 36.7 per cent were former nail-biters, and approximately 34 per cent never bit their nails. The present nail-biters added to the former nail-biters account for approximately 66 per cent of the entire experimental group studied during this year.

4. *Prepotent Stimuli*

During 1933-34, among 89 nail-biters fear was found to be a conspicuous factor. In 1935-36 tenth grade girls said nail-biting occurred when they were in a state of excitement or suspense, as well as when they were unable to do something which they desired to do. This same year 10 nail-biting girls ranked various forms of entertainment for their stimulus value. All of the girls said motion pictures were provocative, eight said games were provocative, six said stories, with the other forms of entertainment having stimulus value for lesser numbers. This year it was also found that during a test situation those parts which require the most effort to solve are the ones that are the most likely to elicit this form of behavior. Of 26 tenth grade nail-biters (both sexes) 19, or approximately 73 per cent said suspense was most likely to elicit nail-biting. During 1938-39, 33 girls, and during 1939-40 among 109 nail-biters of both sexes excitement, suspense, idleness, and unfulfilled desires were given as the causes for indulging.

5. *Duration*

Of the 212 elementary school children studied during 1934-35, it was found that 66.1 per cent of the nail-biters had been indulging from two to four years. The modal year was two.

Over 50 per cent of the nail-biters had desisted before reaching 15 years of age (1939-40).

6. *Awareness*

During 1933-34, of the 89 nail-biters studied 91 per cent were aware of biting their nails. Tenth grade students also said they were aware of indulging. Most of the patients in the children's ward (1936) denied awareness of the act of biting.

7. *Opportunity of Learning*

During 1933-34 statements of elementary school children, and in 1939-40 accounts of tenth grade students show that they learned it from someone else. Among the patients studied (1936) nail-biting in many cases could be traced to the mother, or relatives with whom they had come in contact.

8. *Siblings*

No significant relationship was found between the number of siblings and nail-biting. It was distributed proportionately to siblings at large, occurring most frequently in 3-child families.

9. *Intelligence*

The distribution of intelligence quotients indicated that nail-biters as a group had a slightly lower mean *IQ* than those who did not indulge. In support of this contention was the fact that the "*A*" sections which contain the superior pupils had a smaller proportion of nail-biters, and that the "*C*" sections contributed the largest proportions. Section 6-*A* contained approximately 19 per cent of nail-biters, while Section 5-*C* had 61.1 per cent indulging (1933-34). A more extensive analysis made with tenth grade students concurs with this contention. The number of cases studied was 334 with about an equal proportion of both sexes. The mean *IQ* of the nail-biters was 97.76, and of the non nail-biters 102.19. By breaking down the non nail-biting group into "never" and "former" nail-biters—the former nail-biters had a mean *IQ* of 103.51, and the group who had never indulged had a mean *IQ* of 99.94. The range of intelligence quotients within this experimental group was from 70 to 143.

10. *Neuroticism*

Nail-biters were found to be neurotic but not overwhelmingly so. There were 212 cases in this random sample of 117 boys and 95 girls. The percentage of affirmative responses on the Woodworth-House *Mental Hygiene Inventory* for male nail-biters was 14.1 per cent, and for the control 11.7 per cent. For the female nail-biters the positive responses were 15.1 per cent, and for the control 13.6 per cent. For several items the difference between the nail-biting boys and the male control was more significant. These items together with the percentage of their excess for the nail-biters were: temper tantrums, 21 per cent; mind wandering, 16 per cent; disliking the company of girls, 15 per cent; low marks in school, 14.5 per cent; poor health, 13.6 per cent; fright in the middle of the night, 12.4 per cent; and, consider myself rather nervous, 10 per cent. Among female indulgers the items having positive responses of 10 per cent or more in excess of the control group were: fright in the middle of the night, 29 per cent; feeling ashamed (interest in body), 18 per cent; disturbed over sex, 13.5 per cent; and, getting tired easily, 10 per cent. In one item—feeling of *inferiority*—the female indulgers had a negative difference of 19 per cent, meaning that they felt more superior than the girls in the control group.

During 1939-40, of 300 tenth grade pupils (both sexes) 64 per cent of the nail-biters, 47 per cent of the non nail-biters, and 31 per cent of the former nail-biters exceeded the fiftieth (normal) percentile on the Bernreuter neurotic scale (B1-N) of the *Personality Inventory*.

11. *Sex*

According to the analysis of significant items on the *Mental Hygiene Inventory* the problem of sex as stimuli can be operative, but its contribution is due more to social pressure than sex urge. The hospital cases indicated that sex was at times one of the problems of nail-biters and to this extent it would be significant.

12. *Sense of Guilt*

During interviews the pupils displayed feeling of a sense of guilt by blushing or by trying to evade the issue. This sense of guilt was also evidenced among the hospital patients, particularly as some of the nail-biters denied indulging.

13. *Corporal Punishment*

Using parallel groups of 50 each, 80 per cent of the nail-biters and 60 per cent of the non nail-biters claimed they received spankings at home for misconduct (elementary boys—1932-33). Nail-biters seem to forget punishment more rapidly. Of these elementary boys 40 per cent of the nail-biters and 50 per cent of the non nail-biters said they remembered the spankings for some time.

14. *Conformity to a School Situation*

Nail-biters contributed 80 per cent of the infractions during the first month of school, 45 per cent during the second month, but only 36 per cent during the last two-week interval. For the entire period of eight weeks, 62.5 per cent of the infractions were accountable to the nail-biters.

The non nail-biting group had 62 per cent of their scores exceeding 10 on the Bell *School Inventory*. The former nail-biters had 56 per cent and the nail-biters 53 per cent, indicating the nail-biters to be slightly more conforming in a (formal) school situation.

15. *Facts Believed True of Nail-Biters*

Sixty tenth grade girls (50 non nail-biters, 10 nail-biters) in citing three facts believed true of nail-biters ranked nervousness first (42), excitement second (24), and habit third (20).

16. *Treatment*

Of 123 elementary children (1934-35) having quassia solution applied 75.6 per cent desisted. The first treatment effected the greatest decrease in nail-biting, 29.3 per cent. Each successive treatment diminished in effectiveness. After the fifth treatment no further decrease occurred. The attitude of the nail-biter was paramount in attempting to curb this behavior by negative conditioning.

Among the hospital patients (1936) biting their nails, the patient having the highest *IQ* responded successfully to the olive oil treatment. Those of lower intelligence showed negligible or no improvement.

Among thirty-three tenth grade girls (1938-39) indulging it was found that in 90 per cent of these cases at least one attempt had been made to ameliorate this condition. The most frequent methods used to curb this behavior were: taping the fingers with adhesive, being made to feel ashamed of this behavior, having the hands slapped, fearing blood poison or disease, being paid to stop, and putting iodine or finger nail-polish on the finger nails.

D. CONCLUSIONS

As the evidence stands, the following conclusions although tentative would seem warranted.

1. The incipiency of nail-biting behavior is most likely to occur between the ages of eight and ten years.
2. The incidence of nail-biting varies from group to group.
3. Nail-biting is most likely to occur during excitement caused by fear or suspense, or in situations in which the individual is unable to do what he desires.
4. Nail-biting is frequently claimed to be learned from another

indulger. This learning seems most likely to occur when the individual is in an emotional state.

5. In the majority of cases nail-biters are aware of the act of biting.

6. Compared with non nail-biters, nail-biters reflect a somewhat lower mean *IQ*, however, the difference is insignificant.

7. Nail-biters are slightly more neurotic than non nail-biters.

8. The amelioration of nail-biting by negative conditioning, or by any other technique, will be successful only as the individual is favorably disposed toward it and has a desire to desist.

9. In spite of the nail-biters' apparent conformity they are nonconformists. The nail-biting probably is a form of revolt at having to comply.

E. INTERPRETATION

Summarily, nail-biting as a form of behavior can be explained in this manner. Its original stimulus seems to have been an interference with self-initiated activity on the part of the individual. This at first resulted in an overt emotional manifestation of anger. The motor aspects of the anger response became inhibited by fear of punishment. Nevertheless, the emotional tension persisted. Either during the frustration, or while the emotionalized tension persisted, opportunity and response to an individual biting his nails took place. Occasionally this behavior might be hit upon accidentally, although in a great majority of the cases studied it was directly learned from others. As the individual was in an emotional state the behavior was learned from only one response, or at the most, relatively few. Apparently this form of behavior serves as a motor outlet to reduce tension. Accordingly the individual becomes predisposed to engage in nail-biting on subsequent occasions when emotional tension arises. Thus this behavior becomes a last resort in situations involving frustration, conflict, or suspense serving as a means of reducing fear tensions. It may even persist in adults as a response to annoying situations or memories. In many cases it becomes compulsive, and in such cases is extremely difficult to ameliorate.

To bring this study to a fitting culmination it seems proper to recapitulate briefly the manner in which it integrates with the efforts of other writers. That nail-biting is considered a learned behavior in the majority of cases is given support by Olson, and Chapin and

Royster. The significance of tension as a factor is attested by Kanner, Homburger, Stagner, Jeans and Rand, and Richards. The incidence varies considerably in this study, and in the investigations of Ackerson, Anderson, Stevens, Taylor, and Wechsler. In support of the present contention that the prepotent stimuli consist of situations in which there is strain are Richards, Wechsler, and Morgan. Dunlap considers frustration as the prepotent stimulus. No significant difference of intelligence was found in this investigation for nail-biters and non nail-biters (Viets). In the matter of siblings Viets is also in agreement with this study, namely, that there is no real relationship. The consensus in respect to neuroticism is substantiated by Moll, Rivlin, Cramer, Thom, and Sherman. Ameliorative techniques used by others are application of olive oil by Isaacs, Kanner suggests removal of the tension, Wechsler suggests seeking the cause and paying little, or no attention to the symptom (nail-biting). Manicuring is suggested by Guthrie, and Chapin and Royster. Each of these were found to have some value, although categorically none are infallible with unselected cases. The crux of the problem is the person to be cured.

VI. RECOMMENDATIONS FOR THE AMELIORATION OF FINGER NAIL-BITING

1. Increase the tension-tolerance of the nail-biter (70).

2. Do not attend motion pictures of the suspense or danger variety, or any other entertainment that causes excessive excitement.

3. Make a deliberate effort to relax when becoming tense or excited.

4. Parents should eliminate, as much as possible, conditions known to elicit this behavior in the nail-biter, as suspense, over-straining, etc.

5. Both parents, as well as the nail-biter, should scale down the child's supposed level of aspiration. This will reduce the motivation, somewhat.

6. Do not tease nail-biters, or ridicule this behavior, as it only aggravates it.

7. Show the nail-biter that this behavior is inconsistent with his definition of self (insight).

8. Make certain that the nail-biter is getting sufficient calcium in his diet.

9. If the nail-biter associates with friends who also indulge in this activity he should become acquainted and associate with non nail-biters of similar mental capacity, and of a social-economic status which is compatible with his own.

10. The recalling of the inciting situation in which nail-biting had its genesis oftimes reduces the persisting emotional tension.

11. The elimination of "opportunities for tension and increasing opportunities for emotional release along socially approved lines" (33).

12. Restrain outward expression of fear or anger, this will, in part, reduce the frequency of nail-biting.

13. Nail-biters need someone (adult) whom they respect and with whom they feel secure.

14. The time to deal with our functional disorders is before they have developed (22).

15. The nail-biter should learn to relax, and he should develop an interest in some diversion requiring the activity of the hands such as piano or other musical instrument, needlework, games, etc.

16. The nail-biter's school load should be made compatible with his abilities.

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AN EXPERIMENTAL STUDY OF THE FACTORS OF MATURATION AND PRACTICE IN THE BEHAVIORAL DEVELOPMENT OF THE EMBRYO OF THE FROG, *RANA PIPIENS**

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I. HISTORICAL INTRODUCTION

The attempt to determine the behavioral consequences of beginning life with a germ plasm of given chemical constitution has been constantly confounded by the fact that these consequences rarely, if ever at all, appear by themselves. The behavior that ensues rapidly acquires properties as a result not only of what the organism begins with, but also of how this initial equipment is being used. In brief, then, the incidents of living itself have a cumulative effect, eliminating, creating, reinforcing, modifying the continuous stream of behavior. To those concerned with the problems of heredity and environment, this is an especially familiar statement.

Little satisfaction is derived, at this stage in the progress of psychology, from the frequent declaration that *both* heredity and environment are inextricably involved as determinants of any behavioral sequence. If true, as it may well be, it tells us not enough. In many cases, either of these factors may vary tremendously in significance for the explanation of any activity. The hereditary factor may be at times merely one of many necessary conditions for the specific behavior under observation; the experiential the more important sufficient condition; or vice versa. Nor does it quench our curiosity at all to define the problem out of existence by deciding a priori that the organism, particularly the human organism, is infinitely malleable and that heredity is simply a term used temporarily to conceal our ignorance of the environmental influences at work. Certainly a great deal of evidence has been accumulated in virtually every subdivision of the subject-matter of psychology demonstrating the efficacy of heredity *and* environment. The next step is to refine the problems still further by teasing apart the mutual influences that these innate and acquired characteristics have on each other.

Within recent years, investigators concerned with the analysis of the organism's earliest activities into components attributable to maturation and development have had an opportunity to do exactly this. Of course, it cannot be expected that the relations between heredity and environment in all their diversity will be completely clarified to the satisfaction of everyone concerned by this approach alone. A formula general enough to describe these relations and yet specific enough in its details to apply to the various activities, the hereditary or environmental origins of which are questioned, can come only from an exhaustive consideration of each of these activities itself. Although we cannot optimistically seek shortcuts, we can recognize the fact that some aspects of the general problems may be studied more fruitfully along certain lines than others. The familiar procedure of attempting to hold either heredity or environment constant is unquestionably simpler when the organism studied is still so young that it has not yet come to respond to an environment nearly so complex as it will subsequently be. A mere extension of this is the frequently accepted notion that those early activities which upon their very first appearance are adequate or successful may be regarded as hereditary or as due entirely to the maturation of innate factors. In such a case, the environment has been naturally controlled by the organism's sheer inability to respond to it. If the foregoing remarks are true, then we may well profit by turning our attention to these early phases of the development of behavior.

The very imposing number of investigations in this field forces us, despite their importance, to do little more than refer to the excellent reviews of the literature by Carmichael (9, 11), and consider in detail only the experiments most relevant to those undertaken here. A brief exception may be made in order to recognize a methodological principle of importance. This takes us afield with respect to the animals and activities studied, but remains relevant from the point of view of procedure. Spalding's (40) original observations to the effect that chicks, which were reared under the experimentally imposed condition of restraint from practice, pecked, upon release, as well as normally developed chicks have been superseded by the more painstaking investigations of Shepherd and Breed (39), Bird (2, 3) and Moseley (36) for a reason important to us here. The latter made careful measurements of the activities to be compared and found, as a result, a significant difference in ability between experimental and control animals, not at all noticeable in the absence of such measurement. This need for accuracy of observation and quantitative comparison will be stressed again below.

It must be borne in mind, however, that the aforementioned work began, in all cases, with a fully hatched chick. Movements were restricted only after the chick had broken through the egg. The extremely important investigations of Kuo (27, 28, 29, 30, 31, 32) have brought to our attention the fact that there is a great deal of behavior even before hatching which has a decided influence upon postnatal life. Avery (1), Coronios (18), and Carmichael (10) have made similar observations on the guinea pig, and Minkowski

(34, 35) on humans. If behavior is to be understood at all in terms of its antecedents, movements bearing various degrees of relation to the activity finally studied must be controlled as well. Not simply should the earliest pecking responses be rendered impossible, but all other related activities, such as movements of the head, trunk, etc. This is accomplished only with the greatest difficulty in the case of chicks. However, another series of studies in the same general field, employing other animals more susceptible to the kind of control regarded immediately above as essential, has done much to increase our understanding of the factors influencing the early development of behavior.

Amphibian embryos have been used extensively of late in studies of this nature. They present the important advantage of functioning while they are very young, and because their eggs have no shell the experimental difficulties of controlling this early behavior are virtually non-existent. Coghill (12, 13, 14, 15, 16, 17) in his numerous researches, has given us not only valuable material on the behavioral history of these organisms, but has also added to the richness of his presentation many studies of correlated anatomical growth. The investigations of Harrison (23) and of Carmichael (6, 7, 8), which offer material most relevant to our problem and the experimental attempt to resolve it to be described below, also employed amphibian embryos.

Harrison, whose interest was in the development of *structure,* demonstrated that ". . . all of the constructive processes involved in the production of the specific structure and arrangement of the muscle fibers take place independently of stimuli from the nervous system and of the functional activity of the muscles themselves" (23, p. 218). This was determined by rearing two groups of frog embryos, one in which the nervous system of each animal was surgically removed before the motor nerve roots reached out to the muscle plates, and one in which development proceeded in the absence of muscular function artificially induced by the action of a drug. Histological comparisons were then made of the musculature of the experimental and control groups, the latter serving as a definitive standard. Harrison also made certain cursory observations of the swimming activities of these groups. Although a similarly clear-cut basis for the comparison in the form of some measurable standard of behavior was lacking, he reported the performances of experimentals and controls as indistinguishable. In view of the fact that the animals at this time are extremely small (approximately 7 mm.), the dangers of such qualitative judgments loom large.

This tendency to overlook the need for a careful, *quantitative* examination of the earliest appearance of an activity is found in Weiss's (42) treatment of the problem also. In citing an example of motor behavior without previous experience, he refers to the butterfly which, after complete restraint from movement in the pupal case, breaks through and flies "very handsomely," a performance "of which it suddenly reveals itself to be fully capable." Harrison's (23) discovery of the independence of the growth of a *structure* from its own activity leads one reasonably to expect the structure to respond once it is removed from confinement. The point at issue, however, is whether or not that initial activity is really equal in quality to what is recognized as normal for the species. Shepherd and Breed (39), as well as Moseley (36), found that the first pecking movements of chicks, that were not afforded the normal opportunities for practice, were not nearly so accurate as those of the controls. Spalding, in his investigation, missed this completely because of the crudeness of his observations. The only way, then, to determine whether maturation alone, or use as well, is responsible for the full development of those activities of which the organism is capable is to make careful measurements of such early activities and compare them only then with what is accepted as typical.

The very important researches of Carmichael on this topic must now be considered in some detail. His technique was essentially that of Harrison's in which frog embryos, whose behavior is suspended by the action of a narcotic applied just before the initial twitches precedent to swimming appear, are compared, after a certain amount of growth takes place, with a group reared under normal conditions. His report was that "in varying lengths of time after this first movement after release from the narcotic, but in all cases in less than 30 minutes, the previously drugged embryos showed coördinated swimming movements" (6, p. 54). Here, too, these swimming movements were described as indistinguishable from those of a control group. The qualitative nature of this instrumentally unaided judgment, in the light of our comments above, may be seriously questioned.

The aforementioned 30-minute period between initial twitches and fully coördinated swimming may have been either one of rapid learning or the time taken for removal of the effects of the anaesthetic. Carmichael himself made an attempt to determine which of the two alternatives was correct. By reanesthetizing a group of free-swimming tadpoles, he found that simple body flexures in response to stimulation occurred, upon release from the narcotic, in a period of time roughly corresponding to that of the experimental animals. Several difficulties, however, intervene between this report and the acceptance of the results as final.

In the first place, the animals used in this portion of the experiment by Carmichael were 60 hours older than the animals in the original group. By this time not only are they considerably larger in size, possessed of additional organs, but are more powerful swimmers as well and are therefore no longer strictly comparable with embryos 60 hours younger. Secondly, there is an unresolved difference in these data in Carmichael's two papers which may suggest that certain variable conditions were uncontrolled. In his 1926 paper (6), one finds an average time of 11.5 minutes for Amblystoma and 10.1 minutes for *Rana sylvatica* before the first response (simple body flexure, not swimming) after removal from the anaesthetic appears. The ranges are 5 to 28 minutes for 18 cases of Amblystoma and 7 to 15 for 7 cases of *sylvatica*. In 1927 (7), the average of 4.3 minutes is reported for 18 cases of Amblystoma, with a range from 2 to 7. Finally—and by far the most important consideration of all—these measurements are not of the appearance or restoration of *swimming*, but rather of the *initial twitches* precedent to swimming.

Harrison's discovery of the independence of the growth of a structure from its own activity leads one to expect that stimulation of that structure will lead to a response, however rudimentary, as soon as narcosis is passed. But, this tells us nothing at all about the period whose importance Carmichael himself recognized. He wrote:

> From the initial twitch to the fully coördinated swimming movements, a continuum of increasingly complex responses could be noted in each organism as it developed through the short period indicated above (less than 30 minutes). It is at present impossible to state to what extent this apparent gradual perfection of behavior was due to a process analogous to very rapid learning, and how much of it was due to the gradual removal of the "masking" influence of the drug (6, pp. 56-57).

It is indeed this period which deserves our attention if we are to determine whether the *activity* of a structure while it is developing is a factor in its subsequent behavior. Since this is our problem, it appears to be inadequate to study these primary responses (i.e., initial twitches) except as they may be found to affect later behavior; in this case, fully coördinated swimming movements. Carmichael's investigations offer a rough approximation of the time taken for animals developed in the narcotic to manifest swimming upon their release. No precise measurements are given for the length of time taken by the normal free-swimming embryos which were reanaesthetized and then released to manifest the return of their swimming ability. It now seems extremely important to make such measurements in order to determine whether or not learning or practice occurred in the time between initial twitches and fully coördinated swimming.

It cannot be gainsaid that Carmichael's work, despite the difficulties raised with it above, buttressed by the earlier studies of Harrison (23) and Matthews and Detwiler (33), does establish the fact that behavior, as well as structure, may appear independently of previous activity. However, the standard of this behavior, i.e., whether it corresponds to the norm for a control group reared under normal conditions which do supply opportunities for practice, has been left undetermined.

Carmichael (8), in a later research, compared the swimming of a group of amphibian embryos reared in a sound-proof, dark room with those developed in a noisy machine shop where vibrations afforded extra stimuli. No difference in swimming ability was reported. The attempt to develop a group of these animals under conditions of positive stimulation was only crudely fulfilled by the vibrations of a machine shop. In this study, as well as in his earlier ones, no attempt was made to regulate temperature conditions. Although it is true that the subjection of a control group to this same variable condition obviates some of the difficulties of no temperature control, it is a commonly accepted fact that the rate of development in frog embryos varies directly and significantly with this condition. Pollister and Moore (38) have an informative table indicating this.

II. THE PROBLEM

As a result of the investigations described above, it has been concluded that "the fragmentary movements observed during the embryonic history of motile embryos merely gauge the gradual progress in the differentiation of the underlying functional apparatus without materially contributing to it" (42, p. 569). If this is true, the case *for the inheritance of this function* is clear. *On the other hand, if* this is not true and embryonic movements, themselves partially controlled by elements in the environment, are recognized as an important factor in the development of behavior, our interpretation would have to be recast. It would then mean that heredity alone accounted for, at most, the first appearance of behavior the progress of which was then affected also by its environment.

The determination of the importance of these elementary movements is the purpose of the present experimental inquiry and may be restated in the following, simple question: is the normal exercise of function, i.e., practice, necessary for the perfection of certain simple activities? We mean no more by "the perfection" of certain elementary movements than that which corresponds to the norm in a group of designated age which is reared under the prescribed conditions known as normal or typical. It is clear, then, that we use the word "perfection" here as synonymous with some standard of behavior; and we believe that our knowledge of the development of behavior will be advanced by comparing this very development in experimentally treated groups in terms of some such standard. Our method of meeting this condition will be elaborated presently. It is not, then, a study of the changes in function consequent upon practice of a fully matured organ which is our task here, but rather an attempt to determine whether practice in the rudimentary stages in the development of an organ affects in any way its functional ability upon maturity.

The main experiments undertaken may be divided into three parts: (*a*) the effects of immobilization or lack of use upon the development of behavior; (*b*) the effects of positive stimulation and more than the normal amount of use upon the development of behavior; (*c*) the time taken for removal of the specific effects of the narcotic used to induce immobilization. The procedure employed in each of these experiments can also be divided into, (*a*) a period of development wherein the experimental variables were introduced, and (*b*) a period of testing, wherein an attempt was made to determine the effect of the variables on development.

III. EXPERIMENT I: EFFECTS OF IMMOBILIZATION UPON THE DEVELOPMENT OF BEHAVIOR

The embryos of *Rana pipiens* were used in these experiments not only because they present all the advantages for this kind of work mentioned above, but also because of their general availability. The artificial fertilization of eggs, after ovulation is brought about by pituitary administration, makes possible a constant and abundant supply. No difference between these animals and those which are the products of natural fertilization has been found (38).

It was decided that if the animals were forced to manifest their ability by swimming along a straight line, measurements might be made of the distance swum and the time taken for such distances. Average velocity is then easily determined by dividing the former by the latter and this appears to be a fair quantitative measure of motor ability. Preliminary work with several kinds of troughs finally led to the construction of one which proved satisfactory for our purposes. It was of galvanized iron, the test groove being 100 centimeters long, 7 millimeters wide, and 2 centimeters deep. It was found that animals placed in this groove and stimulated by lightly brushing their tails with a soft, fine brush would swim along the straight path. Although the width of this groove was great enough to permit a reversal of direction, random or circular swimming was eliminated. Each animal during this testing period was given five trials in the testing trough. Both edges of the trough had been previously calibrated so that distance swum was easily measured and time was taken to the nearest fifth of a second. The temperature of the water used in the trough was the same at which the eggs were developed (20° C.).

As in the earlier work of Carmichael, chloretone (acetone-chloroform) was again used in the first part of this study. The drug is known to induce the suspension of all muscular activity by action upon the nerve centers, rather than upon the muscles themselves. This leads, then, to the successful removal of all nervous regulation of muscular activity. If the animals are kept quiet, specific external stimuli to the muscles themselves are precluded. Chloretone is known also to retard the rate of development. Matthews and Detwiler write that "the retardation appears to be the result of general lowering of the growth potentials by the anaesthetic possibly due to diminished power of oxidation in the cells rather than to any specific inhibition of the growing reflex pattern" (33, p. 288). In order to avoid the difficulty which this presents, namely, that if drugged and control embryos were tested after the same number of hours they would not be physiologically and anatomically similar, age of the embryos was determined not in temporal units but in terms of the presence or absence of the external morphologic characteristics peculiar to the stage at which tests were to be made. Aside from this retardation in rate, development proceeds normally when otherwise congenial conditions obtain. Minimal effective concentration of the solution (from .025% to .03%) was employed in the following experiments in order to avoid any of the deleterious effects associated with the use of strong concentrations of this drug. In addition, drugged embryos were kept at a temperature (20° C.) best for development, i.e., growth was rapid, minimizing at the same time the defects which appear when the rate is any greater. The rate of development varies directly with temperature conditions, so that after no differences were found in the behavior of a group reared at 15° C., and a more rapidly developing group reared at 20° C., *compared at morphologically identical stages*, it was decided to keep the experimental (i.e., narcotized) group at 20° in order to minimize the opportunities for injury due to action of the drug. An additional precaution was taken to establish the morphologic identity between experimentals and controls by microscopic examination which would reveal such deformities as bloating of the body or absence of gills in the free-swimming period. Measurements of the length of each embryo were also taken and the relation of tail length to body length was noted. Only those embryos were used in the experiment which were free from deformity and, therefore, comparable morphologically.

All tests were, of course, made during the period of development in which swimming first appears. The various stages of development through which frog embryos pass have been numbered, ordering in some intelligible fashion the successive appearance of different structures and functions. Spontaneous swimming appears in what has been called Stage 20. At this time, the animals are approximately 7 mm. long, the tail equals one-half the body length, and gill formation and circulation appear (Figure 1). Their age in hours depends upon the temperature at which they were raised. This free-swimming period, Stage 20, is approximately 20 to 25 hours long and it is not unreasonable to expect animals at the end of the stage to swim better than those only at the beginning of the same period. If this is

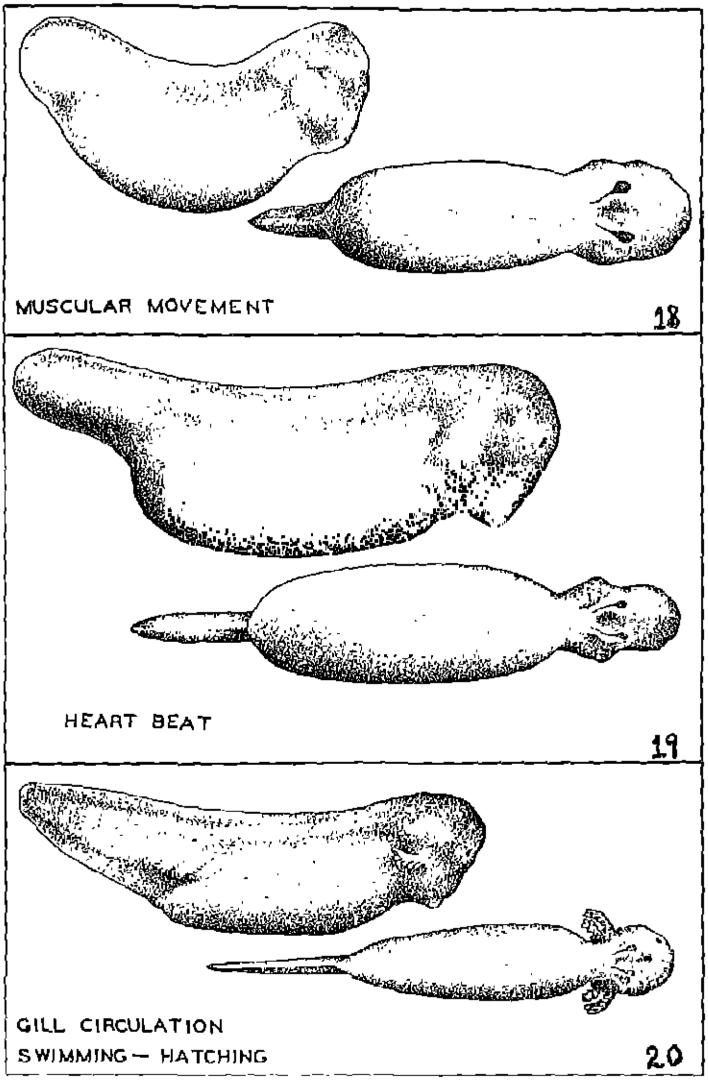

FIGURE 1

EXTERNAL FORM OF *Rana sylvatica* DURING DEVELOPMENTAL STAGES 18, 19 AND 20. (FROM POLLISTER AND MOORE, 38.)

The small differences between *Rana sylvatica* and *Rana pipiens* do not diminish the value of these drawings as illustrations here.

so, our measurements might easily be confused by our ignorance of the point reached in Stage 20 by any group of animals. Although efforts were made to avoid this by careful microscopic inspection of each animal in order to guarantee at least their identity of structure, this source of error remains. A method of rotating experimental and control animals during the test period was precluded by the retarding effect of chloretone on the rate of growth, so that they are not morphologically comparable at the same age in hours.

The method of surmounting this obstacle that finally presented itself accounts for the subdivision of the controls into three groups depending on the length or size of the animal. It was noticed, after many trials, that although animals were in Stage 20, they were frequently 6 or 8 mm. long despite the fact that 7 mm. is the norm. When they were subsequently grouped according to their size, swimming ability was found to vary significantly with it. As a result, in all the other groups employed in other parts of the experiment, only animals 7 mm. in length were chosen in order to insure their strict comparability.

The following steps in the procedure of this first experiment, i.e., *on the effects of immobilization on development*, may be described.

A. PROCEDURE

1. *Group I (Controls)*

a. A group of 36 frog embryos (*Rana pipiens*) was reared in tap water which was kept at the constant temperature of 20° C. by placement in an incubator. The eggs were placed in a covered glass development dish after separation from their gelatinous mass. This is performed simply by teasing them apart with two long needles. Approximately 120 hours after the first cleavage, these eggs reach Stage 20. These embryos were then removed, placed in a bath of Ringer's solution of proper osmotic pressure (simply to duplicate the procedure with the experimental groups), and were then individually tested in the trough. Each animal in this group was 8 mm. long.

b. Exactly the same procedure was employed here with another group of embryos of *Rana pipiens*, the sole difference being that 50 animals were chosen for testing which were 7 mm. long.

c. This group of 36 embryos differed from those above only in being 6 mm. long.

d. This group of 36 embryos was reared at 15° C. Considerably more time to reach the same stage of development as above was taken. The procedure was otherwise the same.

2. *Group II*

Thirty-six animals in this group were reared in the chloretone solution from the first egg cleavage until Stage 17 was reached. The concentration of the chloretone used was .025 per cent to .03 per cent. Because of the volatile nature of the drug, the stender dishes used were covered securely, the edges being first smeared with vaseline. At Stage 17, there is the emergence of the tail bud and, under normal conditions, simple body flexures. At this point they were released and, after two rinsings in Ringer's solution, they continued their development in tap water. At Stage 20, they were tested in the trough.

3. *Group III*

A group of 36 animals was developed in tap water until Stages 17 to 18 were reached. Then the embryos were narcotized by placement in the chloretone solution. Development proceeded there until Stage 20 was reached, when the embryos were removed from the chloretone by means of a small pipette and were given two rinsings in Ringer's solution. One hour after release from the narcotic, during which time they were kept at 15° C. in order to minimize movement, the animals were tested in the trough.

4. *Group IV*

Sixty-four embryos in this group were developed in the narcotic solution from the first egg cleavage to Stage 20. Then after the regular rinsings, they were tested.

B. RESULTS

See Table 1 for a summary description of these groups. The results follow directly in Tables 2 and 3. In these latter tables, the numbers of the groups are the same as those used in the description of each group above. Both speed scores, which were obtained by dividing distance swum as measured in centimeters by time taken in seconds for each distance, and distance scores are presented. Means, sigmas, standard errors of the means, and critical ratios are included.

TABLE 1

SUMMARY DESCRIPTION OF EACH GROUP IN IMMOBILIZATION EXPERIMENT

Group	Type	No. of cases	Temperature	Treatment	Time of test
I(a)	Control	36	20°C.	Development in tap water from stage 0-20.	All animals 8 mm. long; tested at stage 20.
I(b)	Control	50	20°C.	Development in tap water from stage 0-20.	All animals 7 mm. long; tested at stage 20.
I(c)	Control	36	20°C.	Development in tap water from stage 0-20.	All animals 6 mm. long; tested at stage 20.
I(d)	Temperature Control	36	15°C.	*Development in tap water from stage 0-20.*	All animals 7 mm. long; tested at stage 20.
II	Experimental	36	20°C.	Stage 0-17 in chloretone; stages 17-20 in tap water	All animals 7 mm. long; tested at stage 20.
III	Experimental	36	20°C.	Stages 0-17 in tap water; stages 17-20 in chloretone.	Tested 1 hour after release from narcosis at stage 20; animals 7 mm. long.
IV	*Experimental*	64	20°C.	Development in chloretone from stage 0-20.	Tested 1 hour after release from *narcosis* at stage 20; animals 7 mm. long.

TABLE 2

RESULTS, IN TERMS OF SPEED OF SWIMMING, FOR EACH GROUP IN IMMOBILIZATION EXPERIMENTS

Group	No. of cases	M	σ	σ_M	Diff. between means and their reliabilities*
I(a)	36	4.2	3.1	.52	I(a)-I(b)=1.3(2.42)
(b)	50	2.9	1.3	.19	I(b)-III=1.3(5.2)
(c)	36	2.4	2.1	.35	I(c)-I(b)=0.5(1.3)
(d)	36	2.7	1.4	.23	I(d)-I(b)=0.2(.69)
II	36	2.7	1.9	.32	II-I(b)=0.2(.54); II-IV=1.9(5.8)
III	36	1.6	0.96	.16	III-II=1.1(3.1); III-IV=0.8(4.0)
IV	64	0.8	0.61	.08	IV-I(b)=2.1(9.5)

*Figures in parentheses represent the ratio of the difference between each pair of means to the standard error of that difference.

TABLE 3

RESULTS, IN TERMS OF DISTANCE SWUM, FOR EACH GROUP IN IMMOBILIZATION EXPERIMENTS

Group	No. of cases	M	σ	σ_M	Diff. between means and their reliabilities
I(a)	36	10.6	2.8	.47	I(a)-I(b)=0.4(2.2)
(b)	50	9.0	4.0	.57	I(b)-III=4.9(5.3)
(c)	36	6.5	4.4	.73	I(c)-I(b)=2.5(2.7)
(d)	36	7.2	3.8	.63	I(d)-I(b)=1.8(2.0)
II	36	8.0	4.2	.70	II-I(b)=1.0(1.1); II-IV=4.0(4.9)
III	36	4.1	2.8	.47	III-II=3.9(4.6); III-IV=0.1(.17)
IV	64	4.0	3.2	.40	IV-I(b)=5.0(7.1)

In computing these results, the average score for each animal in all five of its trials was used. This was preferred to the use of each trial as the unit of measurement because of our essential interest in group, rather than individual, comparisons.

C. DISCUSSION OF RESULTS

The critical ratios of 2.4 and 1.3 (Table 2) between Groups I(*a*) and I(*b*) and Groups I(*b*) and I(*c*) respectively certainly suggest the extreme care to be exercised in problems of this sort. A mere *difference of one millimeter in size* during the period in which the animals were tested seems to be sufficient to influence their swimming ability considerably. In making comparisons between experimental and control animals, it is therefore essential to hold this factor of size constant.

The *negligible difference in the ability of animals reared at 15° C.* and those at 20° C. (D/σ_D = .69) seems to indicate that speed of development—greater at the latter temperature—has no concomitant in subsequent ability. The absence of any real difference between Groups I(*d*) and I(*b*), reared at the *aforementioned temperatures* respectively, adds to the justification of our choice of 20° C. for all other groups in the first and third experiments.

Group II, developed in chloretone from the first egg cleavage until the earliest *c* and *s* flexures occurred and then released and permitted normal development in tap water from then until swimming appeared, swam as well as the control animals in Group I(*b*). The critical ratio of .54 indicates the absence of any appreciable difference between the abilities of both groups. Thus, when there was no movement to be inhibited by the chloretone, the use of the drug had no observable effect on the development of behavior.

Group III is by far the most interesting one in this series. Developed under normal conditions until the elementary movements *precedent to swimming appear, the animals in this group were then* restrained from practice by the narcotic effect of chloretone. Their movements were thus inhibited until their growth reached the point at which all the morphological signs present in a free-swimming group appeared. Comparison between the controls (Group I *b*) and the *members of this group reveals a significant difference in* speed scores of 1.3 cms. per second (D/σ_D = 5.2). Similarly, distance scores show a mean difference of 4.9 cms. (D/σ_D = 5.3).

The animals of the next group (IV) were reared in an anaesthetic solution of chloretone from the first egg cleavage until spontaneous swimming normally appears (Stage 20). After two rinsings in *Ringer's solution during an hour interval*, the animals were tested and found to present an average difference of 2.1 cms. per second from the controls (D/σ_D = 9.5) (see Tables 2 and 3). Distance scores show a similarly large difference of 5 cms. (D/σ_D = 7.1).

In the experiments above, it seems fairly clearly established that unless these animals in the process of behavioral development are afforded the normal opportunities for the practice of the rudimentary movements that precede swimming, the earliest appearance of swimming behavior does not compare favorably with that of a control group. This decrement in swimming ability, it should be added, is a purely quantitative one concerned solely with the efficiency of movement. No qualitative differences in the strength of swimming, the appearance of tremors of an unusual sort, were evident. The factor of use then appears to be important in its effect upon the development of the activity studied. One might reasonably expect that increasing the opportunities for use might lead to the early improvement of swimming. This, if so, would add to the evidence for the importance of this factor. The second series of experiments undertaken here was designed to make this determination.

IV. EXPERIMENT II: EFFECTS OF POSITIVE STIMULATION UPON THE DEVELOPMENT OF BEHAVIOR

In the second experiment, an attempt was made to ascertain the effects of increased opportunities for practice on the development of swimming movements. It was believed that this condition would be met by the presentation of a greater amount of stimulation than normally afforded by the environment. The simple procedure of suspending beneath the surface of the water in the development dish a tube connected to an air jet was adopted. In this fashion, the water was kept in constant agitation for as long as the experimenter wished, supplying abundant stimulation for the embryos placed there. The adequacy of this stimulation was determined by the increased activity of free-swimming embryos under its influence. It was therefore used during earlier periods of development, i.e., before swimming was possible.

The next four groups repeat the procedure described above, except that activity instead of immobilization was the experimental variable. In addition to this, the difficulty of using the incubator was so great, when the air tube was used, that it had to be abandoned. Since the animals were kept at room temperature, another set of controls had to be used.

A. Group V

Forty-nine animals were reared under normal conditions at room temperature from Stages 0 to 20.

B. Group VI

Thirty-six embryos were developed in tap water kept in constant agitation by the method described above. When Stage 17 was reached, they were removed and development from that point proceeded normally and quietly in tap water.

C. Group VII

Thirty-six animals were reared normally until Stage 17 and were then transferred to water kept in constant activity. As in all other cases, they were tested in the trough when Stage 20 was reached.

TABLE 4

SUMMARY DESCRIPTION OF EACH GROUP IN POSITIVE STIMULATION EXPERIMENT

Group	Type	No. of cases	Temperature	Treatment	Time of test
V	Control	49	room	Development in tap water from 0-20.	Tested at stage 20; animals 7 mm. long.
VI	Experimental	36	room	Stages 0-17 in constant stimulation; stages 17-20 normally.	Tested at stage 20; animals 7 mm. long.
VII	Experimental	36	room	Stages 0-17 normal, quiet environment; stages 17-20 constant stimulation.	Tested at stage 20; animals 7 mm. long.
VIII	Experimental	64	room	Development from 0-20 in constant stimulation.	Tested at stage 20; animals 7 mm. long.

D. Group VIII

Sixty-four animals were reared under conditions of constant activity from the first egg-cleavage until Stage 20, when they were tested in the trough.

E. Results

See Table 4 for a summary description of these groups. Tables 5 and 6 present the results as in the first experiment.

TABLE 5

Results, in Terms of Speed of Swimming, for Each Group in Positive Stimulation Experiments

Group	No. of cases	M	σ	σ_M	Diff. between means and their reliabilities
V	49	2.6	1.8	.26	V-I(b)=0.3(.91)
VI	36	2.3	1.4	.23	VI-V=0.3(.86); VI-VIII=0.1(.29); VI-VII=0.5(1.25)
VII	36	2.8	2.0	.33	VII-V=0.2(.48); VII-VIII=0.6(1.47)
VIII	64	2.2	2.0	.25	VIII-V=0.4(1.1)

TABLE 6

Results, in Terms of Distance Swum, for Each Group in Positive Stimulation Experiments

Group	No. of cases	M	σ	σ_M	Diff. between means and their reliabilities
V	49	7.9	5.1	.73	V-I(b)=1.1(1.2)
VI	36	7.0	4.0	.67	VI-V=0.9(.91); VI-VIII=0.6(.62); VI-VII=1.9(1.5)
VII	36	8.9	6.3	1.05	VII-V=1.0(.63); VII-VIII=2.5(1.9)
VIII	64	6.4	5.6	.70	VIII-V=1.5(1.9)

F. Discussion of Results

Group V, another control group reared this time at room temperature, differed only slightly from the original controls in Group I(*b*). The difference between the means was .3 cm. for speed scores and 1.1 cm. for distance scores. Reliabilities (D/σ_D) for these differences were .91 and 1.2, respectively (see Tables 5 and 6). Despite the fact that these differences are small, all subsequent comparisons for this experiment will be based upon Group V as the control.

Although none of the differences between the means of the four groups in this experimental series were statistically reliable, several other observations worthy of mention were made. Group VI, reared in constant activity from Stage 0 to 17 and then under normal conditions to Stage 20, showed a slight, unreliable tendency to swim not so well as the controls. The difference between the means and the statistical significance of these differences for Groups V and VI using both speed and distance scores respectively were: .3 cm. and $D/\sigma_D = .86$; .9 cm. and $D/\sigma_D = .91$. The animals of Group VI were, as a result of being subjected to constant stimulation from the first egg cleavage until the first simple body flexures, frequently shorter in size than the controls. A great deal of selection had to be made in order to secure animals which were 7 mm. long, an experimental requirement the importance of which Groups I(*a*), (*b*), and (*c*) remind us. This is in agreement with the finding of Goetsch (42) to the effect that constant agitation of the water in which frog embryos were reared exercised a retarding influence on their increase in size. Goetsch worked with *Rana esculenta*, beginning his experiment when they were already 9 mm. in length and carrying it on for four weeks. The embryos of *Rana pipiens* employed in our own work were, of course, much younger, the work beginning in many cases with the undifferentiated egg.

When the animals were developed under normal conditions up until the time that simple body flexures appeared and then continued this development in water kept in constant agitation, they showed a very slight, though unreliable, tendency to swim better than the controls. The difference between the means and the significance of this difference for Groups V and VII, using speed scores as the measure, were .2 cm. and .48, respectively. The corresponding data, using distance scores, were 1.0 cm. and .63, respectively. Although it was reported above, in connection with the first series of experiments, that immobilization and consequent lack of practice of the fragmentary movements precedent to swimming exercised a detrimental effect upon the evolution of swimming behavior, the converse does not appear to be true. In this second set of experiments, in which even greater than the normal amount of practice is made possible, the animals have not been found to swim significantly better than the controls. Of course, it must be recognized as something in the nature of a shortcoming in the experimental technique employed here that the use of a chemical to induce immobilization in the first set of experiments, and of a mechanical factor, i.e., agitation of the water, in the second set limits the comparability of these groups.

Finally, Group VIII, reared in constant activity from the first egg cleavage until spontaneous swimming appeared, tended to swim not quite so well as the controls. The difference between the means of Groups V and VIII in terms of speed and the reliability of this difference were .4 cm. and 1.1 respectively. In terms of distance, the data were 1.5 cm. and 1.9, respectively. The animals in this group, as was noticed in Group VI mentioned above, also demonstrated the effect of development in turbulent water. Great care had to be exercised to choose only those 7 mm. in size at the time of testing.

V. EXPERIMENT III: TIME TAKEN FOR REMOVAL OF THE SPECIFIC EFFECTS OF THE NARCOTIC USED TO INDUCE IMMOBILIZATION

Regardless of the size of the difference between the measurements of the performances of the experimental and control groups, no inferences may be justifiably made until the time taken for the anaesthetic to wear off is determined. In order to do this, a group of 75 animals was raised under the conditions described above for the control group. When these animals reached Stage 20 and swam about freely, they were anaesthetized and were allowed to remain in the chloretone solution for 30 minutes. The embryos were then removed from the narcotic and given two rinsings in Ringer's solution. The members of this group were divided into three subgroups, each tested at varying lengths of time after release from narcosis, as follows: Group *IX*, 15 minutes after release from the narcotic; Group *X*, 30 minutes after release; Group *XI*, 90 minutes after release; Group *XII*, which consists of the animals of Group *IX* above, this time tested 120 minutes after release.

A. Results

See Table 7 for a summary description of these groups. Tables 8 and 9 present the results.

Figures 2 and 3 offer the composite results for all groups graphically.

B. Discussion of Results

The final series of experiments were undertaken simply to test the validity of the results of the first experiment. It is the comparison between Groups III and I(*b*), in particular, which may be legitimately questioned. The point might easily be made that the inferior swimming behavior of Group III is attributable not to the absence of the use or practice of the simple body flexures that normally appear before swimming, but instead to the fact that the anaesthetic used can be washed out only slowly, leaving traces of its effects. If this were true, the animals of Group III were then tested before the specific, inhibitory effects of the drug were eliminated. Those groups in the first experiment in which chloretone was used were tested, in each case, one hour after the narcotic was washed out. Our task is now to report on the final experiment

TABLE 7

SUMMARY DESCRIPTION OF EACH GROUP USED TO DETERMINE TIME TAKEN FOR ELIMINATION OF THE EFFECT OF THE NARCOTIC

Group	Type	No. of cases	Temperature	Treatment	Time of test
IX	Narcotic control	25	20°C.	Development from 0-20 in tap water; placed in chloretone for 30 minutes: two rinsings in Ringer's solution and kept at 15°C. until test.	15 minutes after release from narcosis.
X	Narcotic control	25	20°C.	same as above.	30 minutes after release from narcosis.
XI	Narcotic control	25	20°C.	same as above.	90 minutes after release from narcosis.
XII	Narcotic control	25	20°C.	same as above.	Group IX retested 120 minutes after release from narcosis.

TABLE 8

COMPARISON, IN TERMS OF SPEED OF SWIMMING, BETWEEN NORMALS AND NARCOTIC CONTROLS, INDICATING TIME NECESSARY FOR WASHING OUT ANAESTHETIC

Group	No. of cases	M	σ	σ_M	Diff. between means and their reliabilities
I(b)	50	2.9	1.3	.19	
V	49	2.6	1.8	.26	
IX	25	2.7	1.4	.28	IX-I(b)=0.2(.59); IX-V=0.1(.26)
X	25	3.0	1.8	.36	X-I(b)=0.1(.24); X-V=0.4(.91)
XI	25	2.9	1.8	.36	XI-I(b)=0(0); XI-V=0.3(.68)
XII	25	2.9	1.2	.24	XII-I(b)=0(0); XII-V=0.3(.86)

TABLE 9

COMPARISON, IN TERMS OF DISTANCE SWUM, BETWEEN NORMALS AND NARCOTIC CONTROLS, INDICATING TIME NECESSARY FOR WASHING OUT ANAESTHETIC

Group	No. of cases	M	σ	σ_M	Diff. between means and their reliabilities
I(b)	50	9.0	4.0	.57	
V	49	7.9	5.1	.73	
IX	25	7.4	5.0	1.00	IX-I(b)=1.6(1.5); IX-V=0.5(.42)
X	25	7.6	3.8	.76	X-I(b)=1.4(1.5); X-V=0.3(.27)
XI	25	9.2	4.3	.86	XI-I(b)=0.2(.20); XI-V=1.3(1.2)
XII	25	8.6	4.1	.82	XII-I(b)=0.4(.40); XII-V=0.7(.64)

in which an attempt was made to determine how long it actually takes for the specific effects of the drug to wear off.

The 25 animals of Group IX, which were reared under normal conditions up until Stage 20 when spontaneous swimming appeared, were anaesthetized for 30 minutes in a solution of chloretone (.03%) and, after the usual rinsings, were tested 15 minutes after release from the narcotic. Comparison of the measurements made of their behavior with those of the control Group I(*b*) indicate the negligible difference of .2 cm. per second ($D/\sigma_D = .59$). Distance scores show very much the same thing: 1.6 cms. representing the difference between the means of these groups and 1.5, the reliability of this obtained difference (see Tables 8 and 9).

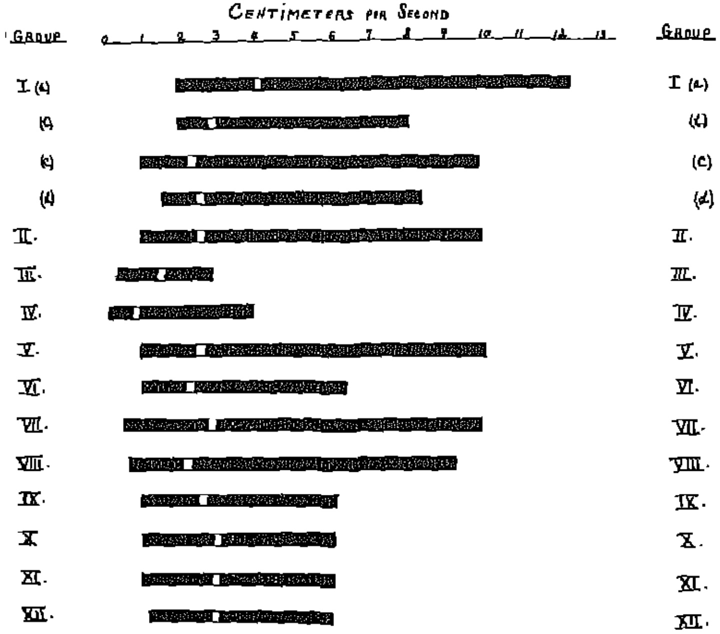

FIGURE 2
Mean and Range of Speed Scores for Each Group

Animals in Groups X and XI, treated the same way as those in Group IX except that they were tested 30 and 90 minutes after release from the narcotic, showed even smaller differences from the control group. Differences between the means for Groups X and I(*b*) and XI and I(*b*) were .1 cm. and 0 cm., respectively. The statistical reliabilities of these differences were .24 and 0. The same comparisons, using distance scores, were 1.4 cm. and .2 cm. Critical ratios here were 1.5 and .20, respectively. Finally, Group XII, consisting of the same animals of Group IX tested this time 120 minutes after release, showed no difference at all from the controls when speed scores were used. Distance scores differed only slightly (.4 cm., $D/\sigma_D = .40$). It may then be concluded from this series of experiments that not only are initial twitches restored in less than 15 minutes after the washing out of the narcotic, but that fully coordinated swimming movements quantitatively indistinguishable from

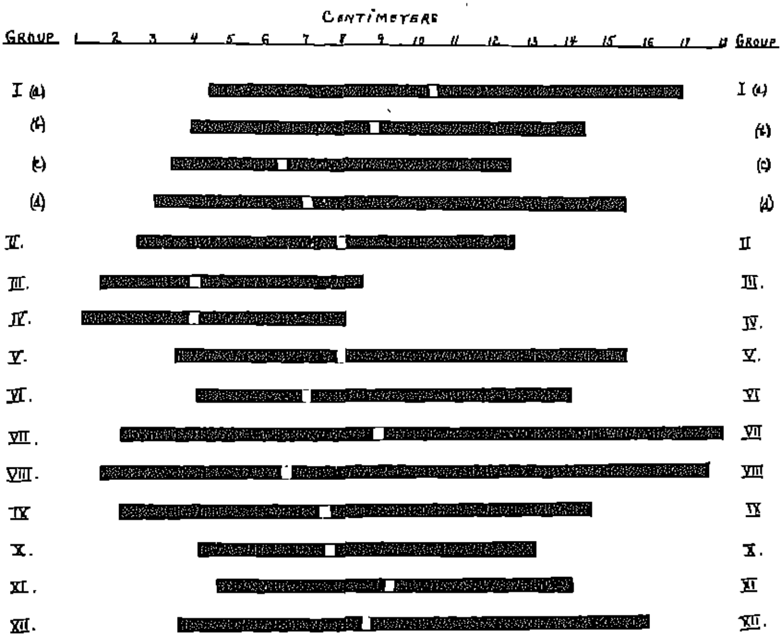

FIGURE 3
MEAN AND RANGE OF DISTANCE SCORES FOR EACH GROUP

those of the experimental group in which immobilization was chemically induced were made 60 minutes after the anaesthetic was washed out, it does seem fairly clear that the decrement in the swimming ability of the experimental animals (Group III particularly) cannot be adequately explained in terms of the specific effects of the drug. The restriction of movement, or the absence of practice, then seems to have been a more important factor.

A single point of contention remains in this last experiment. It may be argued that because the animals in these groups (IX, X, XI, and XII) remained in the anaesthetic solution of chloretone for only 30 minutes whereas those in Group III were subjected to this treatment for roughly 60 to 80 hours, that they were not strictly comparable. This is admittedly an extremely troublesome problem that demands detailed histological work for its solution. In the absence of this, the competent judgment of Matthews and Detwiler, based upon their study of the effects of prolonged treatment with chloretone of amphibian embryos, seems eminently acceptable. They write that:

> . . . it seems that animals subjected to the anaesthetic *up to eight days* exhibit essentially typical reactions shortly after emergence from chloretone, though these reactions are of simpler type than those of the controls, thus indicating considerable retardation in the development of the reflex mechanism, *but no inhibition or injury*. The time required for the initial reaction as well as for the most complete reaction (after removal to tap water) appears to increase more directly in proportion to the increasing strength of concentration of the anaesthetic than with the length of time of immersion (italics mine, 33, p. 282).

The embryos in our own work were kept in chloretone no longer than the limit mentioned above and, in most cases, considerably less than this limit. The retarding effects upon growth rate exercised by chloretone were taken into account and such experimentally treated animals were given more time for development than were controls in order to insure the presence of comparable structures. Finally, the concentration of the anaesthetic used was the minimum strength that was effective. In view of these points, it seems reasonably safe to believe that Groups III and IX, X, and XI were comparable, and that the decrement in the swimming ability of the former was not the result of not having completely washed out the drug.

VI. GENERAL SUMMARY AND CONCLUSIONS

As a result of these experiments, which do reveal the importance of use or practice in the development of behavior—for the animals and activities studied—a doubt concerning the complete validity of an opinion rapidly being accepted by the entire field arises. Based in part upon some of the earlier work which indicated that the structure necessary for complex movements develops normally and *functions perfectly* the very first time, Matthews and Detwiler suggest that " . . . the power of one neurone to activate growth processes in another has origin in the growth phase rather than in the conduction phase of its metabolism" (33, p. 290). Coghill expresses himself in a similar vein, declaring that " . . . it cannot be the definite nervous function within a given neurone that activates complete differentiation either in itself or in another neuroblast" (14, p. 107). So far as anatomical development is concerned, these statements are in all probability true. A tremendous number of studies on transplantation (22, 26, 42) supports this general view. However, behavior is only in part determined by structure, and until our knowledge of the specific effects of a stimulus upon any anatomical segment is more complete, predictions concerning behavior based solely upon an understanding of structure are destined to fall short of accuracy. The experiments reported here serve as testimony to the truth of this assertion. Despite the fact that it is generally accepted that muscular differentiation takes place independently of activity, that muscular structure, histologically indistinguishable from normal, was not capable of functioning in a manner indistinguishable from normal. Thus it must be concluded that although the development of structure may be explained completely in terms of the growth process, the development of behavior is determined only in part by the structures produced by growth and is affected by its own behavioral antecedents as well. Although a structure may function upon maturity without ever having had previous opportunity for exercise or activity, the standard of its behavior was found to be distinctly inferior to that which is measured as normal. Practice, then, during the rudimentary stages of the development of an organ may be said to be a variable, influencing the functional ability of that organ upon maturity.

An attempt was made to determine whether practice in the embryonic development of some function affects that activity in a subsequent stage. The swimming movements of 12 groups of embryos of the frog *Rana pipiens,* ranging in number from 25 to 64, were studied. The experimental factors of immobilization and positive stimulation were introduced during several different periods of development. Immobilization was achieved through the use of chloretone the concentration of which was .025 per cent to .03 per cent. Positive stimulation was afforded by keeping the water in constant agitation. This was done by suspending a tube attached to an air jet beneath the surface of the water. An apparatus was designed which made the measurement of swimming a relatively simple task.

1. The elimination of the factor of use, through chemically induced anaesthesia, was found to create a quantitative decrement in swimming ability. No distinct qualitative differences between control and experimental animals were made evident.

2. The retarding effect of immobilization on functional development took place during the stage of partial movements rather than in the premotile stage.

3. Although this decrement does appear to be the result of the absence of practice and not a consequence of the use of the drug, some additional check in the form, perhaps, of a careful histological examination might lead to a more complete verification of this.

4. Opportunities for activity beyond the normal amount did not lead to better than normal swimming. Only negligible differences were found between controls and experimentals in this series.

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(Manuscripts are printed in the order of final acceptance)

THE FELS CHILD BEHAVIOR SCALES . . . 259
By T. W. Richards and Marjorie Powell Simons

MEASUREMENT OF THE SIZE OF GENERAL ENGLISH VOCABULARY THROUGH THE ELEMENTARY GRADES AND HIGH SCHOOL 311
By Mary Katherine Smith

STEREOTYPES IN THE FIELD OF MUSICAL EMINENCE 347
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THE FELS CHILD BEHAVIOR SCALES*

T. W. Richards and Marjorie Powell Simons

The Samuel S. Fels Research Institute, Antioch College, Yellow Springs, Ohio

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I. PURPOSE

The purpose of this report is to present for the first time a group of rating scales developed at Fels for use in the nursery school situation. The scales were designed to measure what were considered important personality traits in nursery school age children. There are 30 scales measuring 30 defined traits. Although designed for use in the nursery school, there is reason to believe that at least some of the scales are useful in situations other than the nursery school, and possibly for children of other than nursery school age.

The scales are independent units, each scale measuring a single trait. The traits themselves, however, may or may not be correlated. No total score of "personality" is provided by the scales. The traits measured were selected because they seemed of importance in the longitudinal development of the child. Their importance was judged by the members of the psychological staff of the Institute; the selection of 30 was made from a larger group of about 65 traits suggested in definition form. The selection was influenced by the special interests of members of the group: for example, the psycho-physiologist was interested particularly in sampling emotional behavior and physical activity; the home visitor was interested in traits that might be related to parent behavior, which she was rating. The number 30 was considered to be an arbitrary practical limit to the number of scales which could be used periodically in our observational program.

We shall deal in this report with the method of construction, the nature, the reliability, interrelationships, and to some extent with the validity of the scales.

II. CONSTRUCTION

In construction the scales were modelled directly on scales developed to measure parent behavior by Dr. Horace Champney, of the Institute (3). His method for the scaling of behavior cues, the format used for each scale, and scoring of ratings was utilized directly. The single scale, as, for example, the one for *aggressiveness,* comprises a definition or description of the trait, a nine-centimeter vertical line along which are placed cues which are considered indicative of varying degrees of the trait as described. The nature of these cues is somewhat akin to those developed by Conrad (4) for his nursery school scales; and by Macfarlane and her group (7) for clinical use. However, whereas Conrad developed two cues, one at either extreme (with a middle neutral cue), we attempted to develop at least four.

The placement of the cues on the nine-centimeter line was accomplished by using the opinions of seven judges.[1] The judges were members of the psychological staff of the Institute. All had had training in psychology and at least two years of experience with children of nursery school age, either as clinicians or as teachers. The judges' task was to read the cue and to determine for themselves how much of the trait as defined was implied by it. They then indicated on a nine-centimeter line the point in the continuum which they considered the cue to describe.

The behavior described in a cue is, of course, behavior which is supposed to indicate a certain amount of the trait defined. When rating the child, the observer may feel that the child he is rating never behaves in a manner described by any of the cues. But from the cue-statements, he may infer certain degrees of the trait, which would be more or less than he would infer from the behavior of the particular child.

Responses of the judges were compared to see whether they agreed on cue order, linear placement, and appropriateness.[2] In the case of disagreement in order, the cues were rewritten, discarded or replaced until perfect agreement was obtained. Similar revision of

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[1] The writers wish to acknowledge the assistance of Horace Champney, Mary Frances Hartson, Katherine Long, Virginia Nelson, Helen Newbery Norman, Harriet Smith Ringo, and M. A. Wenger for their valuable and patient help as judges.

[2] Champney (3) has elsewhere discussed in some detail various qualities of cues. The principles developed by him were incorporated in the development of cues for these scales.

FELS CHILD BEHAVIOR RATING SCALE: CONFORMITY

Serial Sheet No.

1	2	3	4	5	6	7	8	9	10	Number
										Period of Observation
										Age in Months at End of Period
										Child

The child who conforms reacts according to taught or accepted standards.

- Child's reactions in situations of relation to standards are always in the direction of strict conformity to what is expected of him.

- Established standards are important for the child but may ignore them, for example, in response to the request for conformity given by disliked person.

- Child's conformity is not unusual in any way; he ignores expected standards, for example, if no penalty is likely to ensue.

- Child usually ignores accepted standards, but may conform to them in certain situations in which he desires approval, bids for attention, etc.

- Child ignores established standards, reacts independently of them.

										Consistency: How variable is the child from one situation to another? Enter rating at left: Very predictable 5 4 3 2 1 Very irregular		
										Saliency: How important is this trait in the total pattern of the child? Enter rating at left. Highly characteristic 5 4 3 2 1 Negligible		
										Certainty: Do you feel that your rating is based on adequate evidence? Enter rating at left: Very adequate 5 4 3 2 1 Pure guessing		
										Score	Rater	Date of Rating
										Tolerance	Scored by	Date
										Range	Checked by	Date
1	2	3	4	5	6	7	8	9	10	Number	Tabulated by	Date

Rater's Remarks (continue on back of sheet):

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Affectionateness	*Aggressiveness*	*Cheerful-Depressed*
Definition or Description	Affectionate child indulges in frequent demonstrations, by kissing, fondling, hugging, caressing others. Do not confuse with bidding for attention or desire to ingratiate for other ends. Affectionate child enjoys demonstration itself.	The behavior of the aggressive child is characterized by attempts to dominate social situations, to take the initiative, to plan activity of the group. He need not be successful as a leader; he attempts leadership.	This trait is characterized at the cheerful end by the child's being merry, happy, good-natured, laughing, pleased, and at the depressed end by his being morose, gloomy, discontent, unhappy, sad. Please disregard, on the one hand, the degree to which the child pleases you, and, on the other, the manifest enthusiasm he shows. Consider the degree to which the child probably enjoys himself.
Cue 1	(9.75) Child is fond of affection, glad to be petted, etc. Frequently seen "loving" adults or other children, cuddling close, putting arm around neck.	(9.6) Child habitually tries to direct and dominate others. Bossy.	(9.7) Child characteristically cheerful, pleased, good-natured.
Cue 2	(7.5) Demonstrates and solicits affection frequently, but not out of proportion to circumstances, such as greeting of friend or mother after separation.	(7.7) Child usually attempts to dominate, but may play submissive rôle if an older child or an adult is directing a game.	(8.6) Child usually on the cheerful side, but may be depressed by strongly disappointing or frustrating occurrences.
Cue 3	(4.85) Infrequently solicits affection, but when he receives it does not repulse.	(5.9) Where child feels that he is an authority, for example, in a game which he alone knows well, or in handling a younger child, he is aggressive.	(4.6) Child's good-naturedness rather easily disturbed by adverse circumstances; more easily made sad when tired or ill.
Cue 4	(3.15) On rare occasions, such as when unusually frustrated, solicits caress or reassurance, but generally "cold."	(1.35) No aggression. Child does not attempt to take leadership. Either follows or ignores others.	(3.8) Child easily becomes depressed in response to slight stimuli; is frequently sad, displeased.
Cue 5	(1.4) Child never pets others, avoids receiving such demonstrations. Cold, impersonal.		(2.1) Child usually glum, depressed.

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Competitiveness	*Conformity*	*Cruelty*
Definition or Description	The competitive child responds to the activity of other children by exerting his own effort in the direction of an attempt to excel. The nature of the activity is not important here, only the way in which the child attacks the problem as a social response.	The child who conforms reacts according to taught or accepted standards.	Cruelty implies a tendency for the individual to hurt, harm, torment, disturb, discommode other living organisms for the purposes of his own satisfaction. The child's behavior in this respect can be expressed in physical contact, verbalization, or in social fashion (such as ignoring or excluding).
Cue 1	(9.8) Child is strongly stimulated by competition; increases his effort, tries harder, etc.; keen spirit of rivalry.	(9.5) Child's reactions in situations of relation to standards are always in the direction of strict conformity to what is expected of him.	(9.8) Child is ruthless in hurting others. Without being angered or emotionally upset, he will pull hair, push down, kick, hit, tease. Enjoys making others suffer.
Cue 2	(7.9) Usually stimulated by competition, but quickly becomes discouraged if efforts of rival obviously and markedly excel or outstrip his.	(7.8) Established standards are important for the child but may ignore them, for example, in response to the request for conformity given by disliked person.	(7.2) Child enjoys hurting certain individuals, but does not pick on certain others with whom he may be intimate.
Cue 3	(5.6) In situations of real interest to child, or where child has had experience, he enjoys competition, but if not interested in task or familiar with it, no sense of rivalry.	(5.4) Child's conformity is not unusual in any way; he ignores expected standards, for example, if no penalty is likely to ensue.	(5.7) Only rarely does child exhibit cruelty toward others.
Cue 4	(4.15) A few situations are competitive for the child, but in most is unaware of excellence in activity of others.	(3.8) Child usually ignores accepted standards, but may conform to them in certain situations in which he desires approval, bids for attention, etc.	(0.5) Child never coldly hurts others.
Cue 5	(1.4) Competition completely fails to stimulate child to greater efforts. Child either becomes discouraged or loses interest or simply watches other child, or is unaware of	(1.5) Child ignores established standards, reacts independently of them.	

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Curiosity	*Emotional Control*	*Emotional Excitability*
Definition or Description	The curious or inquisitive child asks questions (to get answers, not simply attention). May also experiment—look around strange surroundings, explore, investigate pocketbooks, flowers, etc., to find out contents or composition.	By emotional control is meant the degree to which the child's overt expression of emotion is inhibited. Emotional expression is curbed to meet the exterior demands of the situation. Child's covert emotion may be intense; expression is inhibited.	This trait is characterized by a low threshold to emotional stimulation. The child reacts emotionally to many (frequent and varied) stimuli. Thus he is easily irritated, emotional, excitable.
Cue 1	(9.75) Child keenly curious. Asks many questions for information about things. Explores, investigates, tries things out.	(9.45) Child customarily controls and restrains emotion. Very highly restrained emotionally.	(9.65) Child is very easily affected emotionally. Highly responsive emotionally. Slight, unexpected difficulty or success, little accidents, casual reproach, and in general relatively mildly stimulating situations readily produce emotion in the child.
Cue 2	(7.55) In new situations tries to investigate principal points but not curious about details or familiar situations.	(6.75) Child occasionally demonstrated outbursts of emotion (as when tired, sleepy, etc.) but inhibits expression rather well in routine situations.	(7.8) Child's threshold of emotional reactivity is low (he is rather excitable), but occasionally he is unexpectedly unresponsive.
Cue 3	(4.9) Within limited areas, child curious (as in regard to sex, mechanical material, or birds), but these areas narrow.	(2.75) Emotional control poorly developed—frequent outbursts.	(5.80) Child's emotional sensitivity neither unusually great nor slight. Would not characterize him as having a high or low threshold.
Cue 4	(1.45) Child lacks curiosity, never asks questions or investigates. Indifferent, or too timid to satisfy interests.	(1.20) No restraint of emotions. Reaction is prompt, frank, free. Never attempts to conceal expression; no inhibition.	(3.50) Child's threshold of emotional reactivity is high (he is rather insensitive), but occasionally he is unexpectedly responsive.
Cue 5			(1.55) Child is very difficult to affect emotionally. Emotionally unresponsive. Exceptionally strong stimuli, and exceptionally pleasant (or unpleasant) situations are required in order to arouse emotion.

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Fancifulness	*Frequency of Gross Activity*	*Friendliness*
Definition or Description	Fancifulness is characterized by the indulgence of the child in make-believe, in imaginary games, situations, stories, even when alone. It is activity not related to the reality of the child's immediate environment.	The active child indulges in gross motor activity most of the time. This rating should be made on the basis of free play observation, wherein child's preference can be observed.	The friendly child tends to prefer company or to seek out and to react positively to other children or adults. Child's success in such contact is some criterion of friendship. Friendliness implies an adaptive response on the part of the child to advances of others.
Cue 1	(9.9) Child extremely fanciful, has imaginary playmates, plays make-believe games. Often places self in imaginary situations or rôles. Makes up own fairy tales, fantasies.	(9.5) Almost always engaged in gross activity, in motion.	(9.9) Shows an open friendliness, to every one; quick to make clearly friendly approaches; does more than meet the other child halfway.
Cue 2	(5.9) Child prefers fanciful play of the type taught to him (such as "Snow White" or "Goldilocks") but does not make up own fantasies.	(8.5) Usually engaged in active play, such as slide, jungle gym, marching, running, but occasionally inactive during brief periods of using quiet play materials.	(8.1) Habitually friendly to others, but on some occasions reserved in this respect (such as in the case of strange children, or of a child with whom he has had a ruckus, etc.).
Cue 3	(3.2) Child will occasionally try a make-believe game with the group, but never initiated this type of play or activity.	(5.9) Child engages in gross motor activity when that type of play is called for, such as in outdoor situations. Also plays quietly when the play situation does not demand gross activity, such as in coloring or in bead-stringing.	(5.85) Individualistic, prefers to remain at a distance but not unfriendly.
Cue 4	(1.50) Child unimaginative, matter-of-fact, realistic; never makes-believe.	(2.7) Usually engaged in quiet activity such as block play, digging in sand, etc.; occasionally joins more strenuous activities.	(3.9) Habitually unfriendly, but on some occasions makes friendly advances to certain children.
Cue 5		(1.15) Extremely inactive, sedentary, stationary.	(2.0) Stands off; is either uninterested in others, or suspicious, antagonistic, bashful, sullen, etc.

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Gregariousness	*Intensity of Emotional Response*	*Jealousy*
Definition or Description	This trait concerns primarily the degree to which the child's interests are directed toward others, the group, etc., or to individual activities which do not necessarily involve the group.	Emotion as expressed or implied is strong, intense, violent. The child is "greatly moved." Disregard the type of emotion, its duration, and the ease with which it is stimulated.	The jealous child shows resentment of his own lot in comparison with that of others and expresses this resentment in intentional negative behavior (trying to render the envied person less enviable). May attack object of resentment, or tattletale, gossip, perjure, or otherwise *defame him*.
Cue 1	(9.55) Child absorbed at all times in group, or in what others are doing. Interested in socially acceptable activities. Keen social responsibility and sensibility.	(9.8) Child's emotional response is characteristically very strong. Child is intensely affected emotionally (whether he expresses his emotion openly and freely or not).	(9.75) Child extremely jealous; quick to resent partiality to another child's supposedly superior clothes, prominence, possessions, etc. Envious.
Cue 2	(7.6) Child prefers group play to individual play, but has certain individualistic preferences, such as consistent choice of bicycle riding, etc.	(8.1) Usually the child reacts rather strongly, but occasionally the intensity of emotion is slight (as when offended by a particularly liked child, or pleased by a child usually disfavored).	(8.1) Usually resentful of good fortune of others, but occasionally ignores it.
Cue 3	(*6.05*) Responds promptly to reasonable demands of group but is capable of happiness alone. Enters group play if it does not make him the goat.	(*5.8*) The *intensity of the* child's emotion is not unusual in any respect; neither great nor slight.	(*4.2*) *Resents flagrant case of* partiality but unaware of or unconcerned with minor causes, etc. Relatively little envy.
Cue 4	(3.8) Rarely volunteers group association; prefers to be alone. Is not unhappy when routine group play is in the order, however.	(3.65) Intensity of emotion is slight, but under unusual circumstances such as a birthday celebration in his honor is occasionally greatly moved.	(1.4) Does not resent or even notice favoritism shown to another child; indifferent to superiority of other children. May admire such superiority.
Cue 5	(1.7) Insensitive to demands of group; individualistic. No responsibility for group. Happier alone.	(1.50) Child's emotional response is characteristically weak. Relatively strong stimulation situations produce only ***mild or weak emotions in the*** child.	

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Kindness	*Leadership*	*Obedience*
Definition or Description	The kind child expresses his sympathy in overt, social behavior conducive to the comfort of others. Considerate, helpful, thoughtful.	The leader influences others; his directions or suggestions are accepted.	The obedient child executes dutifully all requests, commands, etc., made by persons in supposed authority.
Cue 1	(9.55) Child is kind to others, is helpful, comforting. Acts to make others feel better or be happier.	(9.6) Child is highly successful as a leader. His suggestions and directions are accepted by others.	(9.75) Child never objects or disobeys commands, requests, suggestions of adults in supposed authority (teachers, parents, etc.). Is not in these situations resentful or sullen.
Cue 2	(7.7) Kind, except indifference to a few disliked children.	(7.8) Child usually a recognized leader, but sometimes his suggestions are rejected.	(7.8) On most occasions of routine nature child obedient and reasonably cheerful about executing orders, requests, etc. Occasionally may resent unreasonable demands, and express resentment.
Cue 3	(4.2) Indifferent to most children. Usually acts benevolently toward certain friends, comforts and helps them.	(6.3) Child's attempts are successful with certain children or in certain areas of play, but elsewhere unsuccessful.	(6.0) Sometimes disobedient when authority interrupts some engaging task or pastime.
Cue 4	(3.2) Usually indifferent, but on rare occasions is helpful.	(2.85) Child's efforts at leadership are rarely successful.	(3.55) Usually child tries to avoid executions of requests, but not always disobedient. Often requires some insistence and supervision.
Cue 5	(1.5) Child does not help or comfort others. Inconsiderate, indifferent.	(1.5) Child is unsuccessful as a leader. Suggestions ignored or rejected by others.	(1.45) Child objects to many requests, commands, etc. May have temper tantrum, or express deep resentment. Refusals, negativism.

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Originality	*Patience*	*Physical Apprehensiveness*
Definition or Description	The original child shows initiative, thinks creatively, differently, unconventionally.	This trait refers to the patience of the child, his tendency to withhold immediate reaction for whatever reason. The child lacking this tendency is impatient, can't wait to do what he wants to do.	This trait is characterized by fear in situations of impending physical danger to the child (that is, from his point of view). He is fearful when trying the slide or jungle gym for the first time, or if an older child, when first on roller skates, first entering a dark hall, first seeing a new animal, first riding a two-wheel bike. An older child may develop rationalized avoidance behavior of a subtle sort.
Cue 1	(9.7) Child remarkably original; uses play equipment in novel ways. Does not copy others. Originates new games, new ways of combining blocks, etc.	(9.8) *Child is an extremely patient sort.* Waits his turn, reserves action at will.	(9.8) Child is definitely afraid to try new stunts or activities if there is the slightest aspect of danger. His fear is expressed in hesitancy or even refusal to participate, in avoidance, etc.
Cue 2	(8.4) Child unusually unconventional in play, but occasionally may copy a particularly engaging game, an interesting block structure, etc.	(8.85) Only after he has waited a long time does child get impatient.	(7.7) Usually child is fearful in situations of possible danger, but occasionally neglects his fear for reasons of prestige, reward, etc.
Cue 3	(5.4) Child often plays the way he sees others play, does not depend on example of others but works out different, original games by himself on occasion, such as when materials are lacking for activities he has started.	(6.4) Child can wait turns rather successfully, is usually patient, but under some circumstances (such as when he initiated a given group activity) is impatient.	(5.3) Child is fearful only occasionally but is not foolhardy. Does not risk his neck, but does not shirk when others do not.
Cue 4	(4.0) Child usually conventional in play, but on rare occasions, such as when there is not enough material for him to copy others, may do something different.	(3.45) Child occasionally demonstrates patience, occasionally defers action, but usually is off and away to execute plans.	(3.1) Child may be persuaded to exercise caution but usually neglects danger element and goes ahead.
Cue 5	(1.2) Child never does anything differently. Copies others. Plays conventionally.	(1.15) Impetuous, impulsive child; immediately attempts execution of ideas in mind.	(1.25) Child is without fear in situations of impending danger.

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Planfulness	*Quarrelsomeness*	*Resistance*
Definition or Description	The planful child acts according to a previously conceived plan, and will withhold reaction until such a plan is developed.	This trait concerns the tendency for the child to react negatively to other children by taking exception to them, by engaging in conflict, by maintaining a negative stand despite friendly advances from others, etc. The quarrelsome child picks fights, resists others.	This trait is defined as the tendency to react negativistically to demands, requests, or even to expectation of behavior.
Cue 1	(9.8) Child plays purposefully, acting in accordance with a previously made plan.	(9.55) Child's contact with others quickly results in argument, contradiction, dispute, quarreling, fighting, etc. Picks quarrels on slightest provocation.	(9.3) Child's behavior is negativistic; he responds to a request, demand, or even to expectations of response by responding in the opposite direction.
Cue 2	(8.0) Child often plans his activities but at times undertakes play on the spur of the moment.	(7.7) Child is involved in conflicts frequently, but does not initiate them usually. Is recipient of negative behavior in others more than initiator.	(7.15) When tired or feeling off color, child is frequently negativistic, ornery.
Cue 3	(5.6) Child plans occasionally, such as when starting a carpentry project or an elaborate building, but usually starts to play with materials which interest him and lets the play pattern evolve as he goes along.	(5.25) Child will dispute, quarrel or fight when exceptionally wronged or provoked, but usually peaceful.	(4.6) Child's use of negativistic response is a matter of expediency. Will occasionally use such device only for effect.
Cue 4	(3.2) Child usually haphazard in playing, but may make a plan if repeated trial and error attempts fail.	(2.1) Even under great provocation child is peaceful, almost never disputes, quarrels, or retaliates in any way.	(1.10) Child does not resist, is never negativistic.
Cue 5	(1.3) Child never plans his play activity; dives into things carelessly, haphazardly.		

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Sense of Humor	*Sensitiveness*	*Social Apprehensiveness*
Definition or Description	Child sensitive to unusual, bizarre, baroque; laughs and smiles often. May "kid" others and can be "kidded"; sees self in ridiculous light.	Sensitiveness is a complex trait involving an individual's tendency to see in situations a slight or a boost to his prestige.	Social apprehensiveness or shyness is characterized by hesitancy, by fearful behavior in response to social situations. The concept of awareness of physical danger does not directly enter here. The child is afraid of social situations.
Cue 1	(9.7) Child finds many things amusing or funny. Laughs or smiles much. Quick to see ridiculous, bizarre. Kids others successfully, humorously. Takes kidding very well.	(9.7) Quick to note the personal implications of a situation (such as being watched or ignored by other children; or coming into the yard and receiving many or no greetings and invitations to play from other children). Very sensitive; easily hurt and easily flattered.	(9.65) Child shy, apprehensive in social situations. Afraid of social contacts with children and adults. Avoids such. Chronically shy.
Cue 2	(7.6) No unusual amount of laughter, but quick to sense humorous. Often pokes fun at others.	(7.8) Child usually quick to sense implications of a situation, but may remain indifferent to slights or flattery from persons he doesn't like or respect.	(8.15) Child shy, but with a few familiars is at ease. (After long association, as persons in the home, school after some months, etc.)
Cue 3	(4.0) Never laughs at own expense (can't be kidded), but sees humor in very obvious situations. Inclined to be serious.	(6.0) Child is more sensitive to direct remarks than to the implications of a situation, but is not insensitive to the latter.	(5.5) At ease after short association with strangers; gets to know them rather quickly, but shy on first contacts in many cases.
Cue 4	(1.5) Almost never sees anything funny. Cannot be kidded in any way, and never pokes fun at others. Dead-pan.	(3.6) Child usually insensitive or indifferent to the personal implications of a situation, but may occasionally be hurt or flattered by a person whom he admires greatly or of whom he is very fond.	(3.2) To an exceptionally strange child may show some shyness, but usually at ease.
Cue 5		(1.4) Child insensitive or indifferent to the personal implications of a situation. Callous.	(1.25) No shy or apprehensive behavior in response to other children or adults. Child at ease.

FELS CHILD BEHAVIOR RATING SCALE (*continued*)

	Suggestibility	*Tenacity*	*Vigor of Activity*
Definition or Description	The suggestible child is open to suggestion from others, reacts to the new, the different, to change.	This trait is concerned with the degree to which a child maintains a persistent interest.	The vigorous child is forceful, energetic. He may even appear to waste motion or effort. The non-vigorous child has a low energy output. *Caution:* The vigorous child is not necessarily fast (speedy or quick) on the one hand, or efficient on the other. What he does he does powerfully.
Cue 1	(9.6) Extremely suggestible; accepts suggestions indiscriminately, without resistance.	(9.4) Child's active interest in an occupation is unusually persistent; is tenacious over long periods despite difficulty of task or presence of distraction.	(9.6) Forceful, energetic, vigorous. Saws wood energetically. High energy output.
Cue 2	(8.25) In rare instances child resists suggestions but usually suggestible.	(7.75) Child usually tenacious as to interest, but may show shorter attention span when upset, or when activity is much too easy or too hard.	(7.65) Prefers vigorous to passive play and high energy output, but in routine activities not particularly vigorous.
Cue 3	(5.7) Child often resists when suggestions seem unreasonable.	(3.65) Child's interest usually short-lived, but occasionally tenacious if task is extremely novel or engaging.	(5.45) No unusual vigor in movement but can keep on readily when group is engaged in routine vigorous activity.
Cue 4	(3.3) Child rarely follows suggestions, but resistance will break down on occasion.	(2.85) Child's interest dwindles readily. Flits from task to task; no persistent interest.	(3.0) Prefers quiet to vigorous play. Hesitates when things get strenuous.
Cue 5	(1.45) Negativistic; resists suggestions persistently and indiscriminately.		(2.1) Activity is carried out at a low energy level. Play and work is of a mild, placid type.

cues was made if judges were agreed on relative order, but not on placement on the line. Variations in cue placement of 1.5 cms. were tolerated.

In cases of confusion among the judges as to the definition of the trait, appropriateness of the cues, etc., revision was carried on until agreement was obtained.

We present one scale—that for *conformity*. It will be seen that 10 children may be rated on one scale form.

Instructions for rating and scoring will indicate the nature of the various "secondary" ratings.

III. INSTRUCTIONS FOR RATING AND SCORING

A. Making the Observations

1. Familiarize yourself thoroughly with the scales before making observations so as to focus your attention on the variables to be rated.

2. Concentrate on building up a generalized impression of the child's value on each variable, rather than on recording concrete incidents and details.

3. These scales are designed primarily to be used after a period of observation in a relatively standard situation (such as a nursery school group). Probably it is best to rate the child only after a minimum observation period of two weeks. This does not mean that the scales cannot be used on the basis of shorter periods, but such use should be evaluated on its own merits. In rating the child, utilize as far as possible *all* the observation you have had of him within the limits of time and situation.

B. Making the Ratings

1. Consider each rating to cover a recognized observation period; be careful to avoid bias from previous ratings.

2. If rating a group of children try to approximate a constant time after the observation for doing the rating.

3. Probably you should not rate a single child at any one time. Rate in groups if possible, rating all in the group on each variable before passing to the next variable.

4. Compare freely one child with another, as the rating proceeds, revising previous ratings as needed, so that when completed the sheet checks for absolute ratings, and for comparative rankings as well.

5. In rating a child with reference to others, disregard age as far as you can. Rate his behavior.

6. Treat each scale as a smooth gradation from one extreme to the other. Use the cue points merely as points of reference in building up your concept of the total variable, rather than as discrete items to be checked.

7. Each variable is a complex of loosely correlated elements, and is defined by the descriptions and all the cues on the sheet taken as a whole. Avoid mere reference to the "name" of the variable; the name is merely a convenient handle for reference and may be very misleading if taken by itself to define the variable.

C. THE RATING SHEETS

1. Different ratings on the same sheet are identified by "No." (1 to 10), and these numbers should correspond throughout a batch of sheets done at one time and on a constant group of children.

2. Above left you will see boxes designated on the right as *Period of Observation*, *Age in months at end of period*, and *Child*. Enter in the first box the dates beginning and ending the observation period, in the second box the age of the child indicated, and in the third the child's name.

3. *Primary Rating:* Your principal entry on the rating line is an "*x*" to be placed directly on the line at the point best representing your judgment of the location of the ratee on that scale. This point is termed the "score." It may fall anywhere along the line from one extreme to the other, regardless of whether it falls opposite a cue point or somewhere between or beyond the cues.

4. *Secondary Ratings:*

(*a*). In addition to the principal rating, you may indicate by means of horizontal dashes (—) the limits on the scale between which the rating score would have to fall to be consistent with your judgment. (In other words, place the dashes in such a position that if another rater should place his "*x*" anywhere between them you would feel that he probably agrees with your judgment, on the basis of the same sample, whereas if his "*x*" falls outside your dashes his judgment probably differs significantly from yours.) These points are termed the "upper and lower limits of probable score." The interval between them is called the "tolerance."

(*b*). Also you may indicate the range through which the child varies from occasion to occasion by entering a convex curve (⌒) across the line at the highest point you know of for that ratee, and a concave curve (⌣) for the lowest point.

(*c*). In the two boxes immediately under the rating line enter your numerical ratings for "saliency" and "certainty" respectively, on a five-point scale as indicated.

Saliency: Two traits may both rate very high on the line, and rater may be very certain of both. But one of the traits may be a constantly potent component of the child's personality whereas the other seems but slightly significant. These traits are then said to differ in "*saliency*." A given trait may have differing saliency for different children.

Certainty: The following interpretation is suggested for "certainty" *rating:*

(5) Evidence is abundant and clear-cut for the occurrence of this trait at the rated value during the period since my last rating.

(4) Evidence is quite adequate—I feel safe in evaluating the trait as above for the period covered.

(3) Evidence is fair; or, I would feel uncertain if it were not for inference from previous ratings and observations.

(2) Evidence is meager; or, largely inferred from earlier data.

(1) No tangible evidence; nothing more than a vague feeling which I can't justify; or entirely inferred from previous evidence.

5. In the space to the right under "Date of Rating" enter the date you made your rating.

6. Rater's "remarks" should be started in the space at the bottom of the sheet and run over onto the back if needed. Identify remarks by the number of the child on the sheet. Remarks should include such items as:

(*a*) mention of anything unusual about the conditions of observation or rating;

(*b*) exceptions taken to the definition of the trait as given;

(*c*) peculiarities of the child in regard to this trait but not adequately indicated by the rating;

(*d*) any other qualifying remarks or mention of difficulties encountered in using the scale.

7. Please indicate at the bottom of the sheet the situation in which observations were made, as "nursery school," "clinic," "home," "playground."

D. SCORING

Scoring is done by means of an ordinary millimeter scale. Place the scale along the rating line so that the bottom end falls at 9.5 millimeters. Since the line is designed to be 90 millimeters long, the top of the line will now fall at 99.5. Now for each of the five marks on the rating line read off the value to the nearest millimeter. This gives a minimal value of 10 and a maximal of 99. The reading for the "*x*" gives the score directly. The tolerance and the range are readily obtained by subtracting the respective lower limit readings from the upper.

> In case less refined indices are desired the above score may be converted into score on a nine-point scale simply by neglecting the units digit; thus a score of 78 becomes 7, etc. The tolerance and the range should not be so treated. In case readings appear on the scale below 10 or above 100, they should be read as 10 or 100 respectively.

The question of whether or not it is valid to consider the refinement of a rating scale as sufficient for more than seven points (as Symonds, 10, would maintain) is somewhat unsettled. Champney and Marshall (2) have shown that the intercorrelation between ratings of one observer for some traits was increased where many more than seven rating scale points were utilized; more reliable ratings were made in these cases when as many as 20 to 25 points were used. In fact, his reliability coefficient decreased very little when he used all 90 points.

In the tabulation on pages 265 to 274 appear the trait descriptions and cues with their linear placements in centimeters for all 30 scales.

Table 1 presents means and standard deviations for two groups of nursery school children measured in the Fels study; the individual scores for these distributions were obtained for the most part by averaging ratings of three observers. These two groups include all the children who came to the Fels nursery school in two years. They came in sub-groups of from 8 to 10 children each. In the case of one sub-group in the first year only two observers rated the children. Three ratings were made in all other sub-groups. The effect of having only two raters for this single sub-group applies, therefore, to the scales used in the first total group (1938-39).

It will be seen that there are differences between the means of the two years' ratings; these differences are attributable to a number of factors. The number of cases was small, different raters were involved during the two years, and certain cases were unique to one group. The chief differences are found in the scales for *fancifulness, jealousy, resistance, sensitiveness, social apprehensiveness, suggestibility,* and *vigor of activity.* The inter-year differences for these scales had critical ratios of two or more. The difference in regard to *fancifulness* may be due, we believe, to the fact that an extremely fanciful child in the group the first year gave the raters a vivid picture of an extreme in this trait, and they rated the other children lower. Possibly the children in the second year were overrated because this extreme child was not in the group.

TABLE 1
MEANS AND SIGMAS FOR THIRTY RATING SCALES OF TWO GROUPS OF CHILDREN MEASURED IN THE FELS NURSERY SCHOOL

Scale	Group I 1938-39 No. of cases	Group I 1938-39 Mean	Group I 1938-39 Sigma	Group II 1939-40 Mean (n = 40)	Group II 1939-40 Sigma (n = 40)
Affectionateness	35	52.1	13.1	48.4	15.6
Aggressiveness	33	51.9	22.9	52.8	20.6
Cheerfulness	33	74.6	14.8	71.7	15.5
Competitiveness	35	52.5	13.4	51.6	19.3
Conformity	33	66.1	15.4	67.4	14.7
Cruelty	33	30.2	15.8	34.9	16.4
Curiosity	35	65.4	13.8	60.3	16.5
Emotional control	35	63.2	16.1	58.0	19.5
Emotional excitability	35	57.8	14.3	61.3	15.8
Fancifulness	33	35.8	17.2	44.5	13.9
Frequency of gross activity	33	59.5	16.8	59.5	19.2
Friendliness	35	71.5	14.6	70.5	13.8
Gregariousness	35	65.0	16.2	62.3	17.5
Intensity of emotional response	35	61.4	11.7	65.7	13.1
Jealousy	35	30.6	10.6	43.4	19.2
Kindness	33	47.2	17.6	43.4	18.1
Leadership	33	48.9	18.5	48.1	21.4
Obedience	35	75.0	12.8	69.2	15.1
Originality	35	49.6	12.5	44.5	10.9
Patience	16	62.4	22.0	60.1	23.4
Physical apprehensiveness	33	49.0	15.3	53.7	14.1
Planfulness	33	46.9	15.6	46.7	17.8
Quarrelsomeness	35	52.6	18.5	53.2	20.8
Resistance	33	38.9	9.8	48.2	18.0
Sense of humor	35	63.8	15.6	56.7	15.9
Sensitiveness	33	45.4	13.5	56.5	13.6
Social apprehensiveness	33	37.7	18.6	49.2	13.3
Suggestibility	35	72.8	11.0	60.1	12.5
Tenacity	33	58.4	17.2	58.3	21.1
Vigor of activity	35	56.4	17.7	63.8	19.0

In regard to the remaining differences it should be pointed out that there was a rather large group of children who were two-year-olds the first year, three-year-olds the second. This slight shift in age-sampling might account for some of the differences in behavior as indicated by the means, to the extent that three-year-olds tend to differ behaviorally from two-year-olds. Indeed, certain scales which show significant differences in their means from year to year do correlate with chronological age (over the full age period from two to five), *jealousy, fancifulness,* and *sensitiveness* particularly (see Table 7). But certain significant differences between means were found where age correlation was negligible, and some scales related to age over the full period showed no shift from 1938-39 to 1939-40. Differences in rater personnel may have accounted for more than did the differences in sampling. It is probably best to consider these measures of central tendency and dispersion as tentative until considerably larger groups can be rated, and until differences between raters can be studied more intensively.

IV. RELIABILITY OF THE SCALES

Evidence of two main types is provided for evaluation of the reliability of the scales. (*a*) Correlations between individual raters; (*b*) correlations with other measures, such as correlations between scales, with external variables or communality of the single scale with the remaining scales in the correlation matrix.

The data used for these correlations as well as for other correlations presented in this report, excepting as indicated, were derived from at least one month's observation of the child.

Since the Fels children were observed in sub-groups of from eight to ten children relatively selected for chronological age, the correlations between raters were based on the total group ($N = 33$ to 35) or on small samples of eight to ten, each of which was somewhat homogeneous for age.

The raters for the 1938-39 series were two nursery school teachers, one with graduate work and nursery school training, the other the wife of a psychologist, a college graduate who had majored in biology and psychology, an experienced mother whose technical sophistication in psychology was appreciable. The third rater was a graduate student in psychology, a trained nursery school teacher. In the 1939-40 series the third of these raters coöperated; the remaining two workers were a trained nursery school teacher and graduate student in psychology, and a mother who had had considerable contact with young children while driving them from their homes to nursery school.[3]

Since three raters observed the children it was possible to obtain three inter-rater coefficients: *AB, AC, BC.* The three coefficients for any scale for any group were averaged by using the quadratic mean.[4]

In Table 2 appear mean Pearson coefficients for the total group of 1938-39, and for sub-groups within the same year. Since these were four separate sub-groups the mean correlations represent the quadratic mean of the four quadratic means of the three raters for each of the four groups. Similar coefficients for three sub-groups

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[3] The writers wish to acknowledge the help of Miss Katherine Long, Mrs. Clarence Leuba, Mrs. D. A. Magruder, and Miss Margaret Slutz, who acted as raters. One of the authors, M. K. Powell Simons, served as rater both years.

[4] The term "mean" when used hereafter in this report in connection with correlation coefficients refers to the quadratic mean.

TABLE 2

MEAN INTER-RATER CORRELATIONS FOR VARIOUS GROUPS OF FELS CHILDREN AND THE SPEARMAN-BROWN CORRECTIONS FOR THESE COEFFICIENTS

	Raw means			Spearman-Brown		
	1938-39		1939-40	1938-39		1939-40
Scale	Total (Pearson)	Sub r_p	Sub r_p	Total (Pearson)	Sub r_p	Sub r_p
Affectionateness	.54	.57	.64	.78	.80	.84
Aggressiveness	.77	.86	.81	.91	.95	.93
Cheerfulness	.71	.71	.70	.88	.88	.88
Competitiveness	.67	.57	.60	.86	.80	.82
Conformity	.39	.68	.79	.66	.86	.92
Cruelty	.55	.73	.80	.79	.89	.92
Curiosity	.31	.52	.53	.57	.76	.77
Emotional control	.59	.67	.73	.81	.86	.89
Emotional excitability	.56	.61	.70	.79	.82	.88
Fancifulness	.71	.62	.38	.88	.83	.65
Frequency of gross activity	.76	.68	.67	.90	.86	.86
Friendliness	.68	.79	.52	.86	.92	.76
Gregariousness	.66	.68	.66	.85	.86	.85
Intensity of emotional response	.51	.59	.62	.76	.81	.83
Jealousy	.62	.55	.76	.83	.79	.90
Kindness	.65	.61	.62	.85	.82	.83
Leadership	.78	.71	.75	.92	.88	.90
Obedience	.64	.68	.80	.84	.86	.92
Originality	.42	.67	.74	.68	.86	.90
Patience	.70	.72	.78	.88	.89	.91
Physical apprehensiveness	.53	.58	.61	.77	.81	.82
Planfulness	.73	.58	.82	.89	.81	.93
Quarrelsomeness	.80	.76	.93	.92	.90	.98
Resistance	.72	.83	.89	.88	.94	.96
Sense of humor	.74	.73	.54	.90	.89	.78
Sensitiveness	.35	.64	.39	.62	.84	.66
Social apprehensiveness	.70	.80	.60	.88	.92	.82
Suggestibility	.58	.70	.52	.81	.88	.76
Tenacity	.51	.58	.82	.76	.81	.93
Vigor of activity	.78	.72	.72	.91	.89	.89
Mean (rms)	.64	.68	.69	.84	.86	.86

of the 1939-40 season are presented in the third column. It should be recalled that only one rater was common to both 1938-39 and 1939-40. All sub-group correlations are corrected rank-difference coefficients (r_p).

The coefficients in the first three columns of Table 2 suggest that certain of the scales are of tolerable reliability when used by a single observer. The means of these coefficients are higher than the values usually presented for rating scales.

The child's score for the purposes of research in the Fels study is not that of the single rating, but rather a mean of three rated scores. It is obvious that the scales when used in this way are more reliable. An approximation to the inter-rater reliability for averages of three ratings per child was made by using the Spearman-Brown prophecy formula developed for use in connection with lengthening the test by increasing the number of items. The corrections calculated from the single rating coefficients by means of this formula appear in the fourth, fifth, and sixth columns.

For certain scales the uncorrected reliability coefficient was less than the correlation of the scale with some external variable (another scale). This discrepancy was due, we believe, to the fact that means of three ratings were used in the correlations between variables, whereas the inter-rater correlations were calculated on the basis of single-rater scores. Thus, the logic of applying the Spearman-Brown prophecy formula to the reliability of the scales when three ratings were averaged seemed sound.

The material regarding intercorrelation between the scales appears in the next section of this report. We have, however, selected from this material the highest correlation of any scale with any other scale, and the square root of the communality, obtained from a Thurstone factor analysis (to three factors) of the intercorrelations. This communality function, *h*, in the last column of Table 3, represents an approximation to the maximum correlation of each scale with all the other scales, or better the co-variation of each scale with the others. These coefficients are presented in Table 3.

It is apparent that in some cases the correlation of a scale with another scale approximates its corrected reliability coefficient.

The mean value for the group of corrected correlations—if we use the highest mean rater-correlation (whether it be total group or sub-group) as our index for any one scale—is .894. The range is from .77 for *curiosity* to .98 for *quarrelsomeness*.

Since the total group of children ranged in age from 22 to 72 months, it might be suggested that, to the extent that certain traits are correlated with chronological age, they might demonstrate a spuriously high inter-rater correlation. Correlations with chrono-

TABLE 3

LARGEST INTER-RATER COEFFICIENT AND LARGEST CORRELATIONS WITH OTHER VARIABLES AND COMMUNALITY OF EACH SCALE

Scale	Largest reliability coefficient	Largest coefficient with external variable	3-Factor Communality *h*
Affectionateness	.84	.54	.28
Aggressiveness	.95	.81	.91
Cheerfulness	.88	.79	.83
Competitiveness	.86	.90	.86
Conformity	.92	.76	.83
Cruelty	.92	.89	.84
Curiosity	.77	.65	.68
Emotional control	.89	.81	.83
Emotional excitability	.88	.81	.84
Fancifulness	.88	.56	.66
Frequency of gross activity	.90	.89	.88
Friendliness	.92	.73	.86
Gregariousness	.86	.81	.84
Intensity of emotional response	.83	.76	.75
Jealousy	.90	.74	.89
Kindness	.85	.67	.81
Leadership	.92	.80	.91
Obedience	.92	.82	.86
Originality	.90	.73	.76
Patience	.91		
Physical apprehensiveness	.82	.80	.77
Planfulness	.93	.76	.76
Quarrelsomeness	.98	.88	.92
Resistance	.96	.82	.90
Sense of humor	.90	.79	.79
Sensitiveness	.84	.54	.72
Social apprehensiveness	.92	.72	.88
Suggestibility	.88	.82	.87
Tenacity	.93	.76	.57
Vigor of activity	.91	.89	.87
Mean (rms)	.89	.77	

logical age are presented in the following section. It should be pointed out here, however, that the effect of partialing out the correlation with chronological age was to lower certain of the corrected inter-rater (total group) coefficients from .00 to .09 points. Those most greatly affected were traits correlated, of course, with chronological age to some extent. Drops of .05 or more were:

Sensitiveness	.62 to .53
Competitiveness	.86 to .78
Jealousy	.83 to .77
Leadership	.92 to .87
Planfulness	.89 to .84
Gregariousness	.85 to .80

Eleven of the 30 coefficients were unchanged by this procedure; five were lowered by .01, two were lowered by .02, three were lowered by .03, three were lowered by .04.

It may be concluded, we believe, that chronological age does not greatly alter the picture of reliability of the scales. It is important to consider, too, the probability that in the usual nursery school situation an age range of from two to five is usually maintained. The "spurious" effect on reliability caused by spread of chronological age is probably a common effect, and to be considered as much a causal as a confusing factor in reliable rating.

From this evidence on the reliability of the scales, then, we could say that as long as a child's final score represents the average of three ratings, as long as at least one month's observation precedes the rating, and as long as the raters have some degree of familiarity with children and the scales, the scales are of considerable reliability. When three ratings are used, as they are at Fels, 16 scales demonstrate inter-rater reliability of .90 or more, and only one shows less than .80. Under these conditions, if one rating is used, the reliability ranges from .53 to .95; if an average of two ratings is used, the range is from .69 to .97. These figures are based upon the greatest reliability demonstrated, whether for sub-groups somewhat homogeneous for age, or the larger distribution of children of the full nursery school age range.

A. THE RATER'S AGREEMENT WITH OTHER RATERS FOR THE SAME OBSERVATION PERIOD COMPARED WITH HIS SELF-CORRELATION FOR TWO PERIODS

Two groups of children who had been rated on the basis of one month's period in the nursery school came in for a two weeks' observation period about six months later. For 25 scales it was possible to obtain mean correlations between two raters for one period and between ratings of the same raters for a second period. These means would be represented by the formulæ:

$$\overset{\text{Inter-rater}}{\sqrt{\frac{r^2_{RA_I\,RB_I} + r^2_{RA_{II}\,RB_{II}}}{2}}} \qquad \overset{\text{Re-rater}}{\sqrt{\frac{r^2_{RA_I\,RA_{II}} + r^2_{RB_I\,RB_{II}}}{2}}}$$

where R_A, R_B, refer to raters, and *I* and *II* refer to first and second observation periods for the same group of children.

Fifteen of the 25 scales were used with two groups twice, once in the fall, once in the spring ($N = 7$, $N = 8$); 10 of the scales (those marked with an asterisk) were used twice in this way, but only with the second group of eight children.

Comparisons between inter-rater and re-rater coefficients (r_p) appear in the following tabulation, in order of the differences between the coefficients (Table *A*). An asterisk indicates a variable for which one group of eight children was used. For all other scales 15 children were used.

TABLE *A*

	Inter-rater	Re-rater
Competitiveness	.50	.79
Curiosity	.50	.74
Affectionateness	.47	.70
Sense of humor	.56	.71
*Social apprehensiveness	.76	.90
*Fancifulness	.57	.67
*Leadership	.71	.80
*Cruelty	.66	.73
Friendliness	.65	.71
Vigor of activity	.84	.90
Suggestibility	.65	.68
*Physical apprehensiveness	.65	.68
*Aggressiveness	.90	.92
Emotional Control	.79	.80
Quarrelsomeness	.80	.81
*Frequency of activity	.86	.85
Emotional excitability	.80	.78
*Tenacity	.52	.50
Gregariousness	.75	.72
Obedience	.71	.66
Jealousy	.75	.63
Originality	.73	.55
*Sensitivity	.68	.44
*Kindness	51	.18
Intensity of emotional response	.64	.25

Any attempt to interpret the findings above should include the following considerations:

In the case of high inter-rater agreement and lower re-rating, it is possible that the child's behavior fluctuates. Raters are more agreed that for a certain period his behavior was of a given character than that he behaves in this respect in the spring as he behaved in the preceding fall. That is, factors operated to place the raters in more agreement at one time than they are with themselves over a long period. In the case of the re-rater reliability, it is possible that (*a*) children's behavior in these characteristics tends by and large to be more consistent than for others, and (*b*) that the rater's own conception and use of the scale is meaningful and valid for *him*, but is not necessarily in agreement with the notions of other raters.

The traits on which the child's behavior seemed to vary and on which raters were relatively more agreed are, according to this rather meager evidence, *intensity of emotional response, kindness, sensitiveness, originality*, and *jealousy*. The traits for which the rater's own conception seemed relatively adequate but upon the conception of which he was in considerably less agreement with his fellow raters—traits in which the child may tend to be consistent—are *competitiveness, curiosity, affectionateness, sense of humor, social apprehensiveness*, and *fancifulness*. These groups of traits do not seem to differ tremendously. There may be more of the episodic implied in the former group of traits, and more of the vagueness of definition in the latter.

As suggested, the data is too meager for rigorous interpretation. We are anxious to follow up this analysis with more adequate sampling of cases and observation.

B. RELIABILITY OF THE SCALES IN NURSERY SCHOOL SITUATIONS OTHER THAN FELS

Through the kindness of the University of Chicago Nursery Schools[5] and the Antioch Nursery School of Yellow Springs[6] we were able to obtain ratings of (in Chicago) six groups of 10 children each, two groups being rated by a pair of teachers, and two separate groups of 10 each rated at Antioch College by undergraduate student teachers. The Chicago ratings were made twice; each pair of teachers rated her children, and three months later rated an additional 10, many of whom had been rated earlier.

By means of rank difference coefficients it was possible to get group correlations and average these quadratic means for a given

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[5] We are indebted to Mary Elizabeth Keister, Principal, and to Helen Burnett, Frances Spano, Margaret Slutz, Elise Brown and Betty Bass, who made ratings.

[6] We wish to thank Virginia Nelson, Edla Mills, and Mrs. Joan King for their coöperation in the rating project.

TABLE 4

MEAN INTER-RATER CORRELATIONS FOR THREE NURSERY SCHOOLS AND TWO TYPES OF TEACHERS

Scale	Fels 1st rating	Chicago teachers	Antioch students
Affectionateness	.57	.55	.48
Aggressiveness	.86	.77	.68
Cheerfulness	.71	.55	.92
Competitiveness	.57	.53	.84
Conformity	.68	.71	.73
Cruelty	.73	.76	.84
Curiosity	.52	.81	.45
Emotional control	.67	.57	.91
Emotional excitability	.61	.67	.55
Fancifulness	.62	.54	.47
Frequency of gross activity	.68	.71	.68
Friendliness	.79	.66	.48
Gregariousness	.68	.69	.54
Intensity of emotional response	.59	.67	.28
Jealousy	.55	.57	.70
Kindness	.61	.52	.58
Leadership	.71	.83	.86
Obedience	.68	.67	.85
Originality	.67	.72	.35
Patience	.72	.73	.69
Physical apprehensiveness	.58	.64	.43
Planfulness	.58	.93	—.34
Quarrelsomeness	.76	.68	.80
Resistance	.83	.75	.91
Sense of humor	.73	.65	.47
Sensitiveness	.64	.48	.23
Social apprehensiveness	.80	.63	.71
Suggestibility	.70	.48	.55
Tenacity	.58	.65	.27
Vigor of activity	.72	.71	.63
Median	.68	.67	.60

nursery school. In interpreting Table 4 it should be kept in mind that the Fels ratings represent the mean coefficients for three identical raters for four groups, the Antioch ratings those of two identical raters for two groups; the Chicago ratings represent two ratings by three pairs of raters, each pair rating on two different occasions. These in the second age groups in some cases contained the children previously rated.

TABLE *B*

Fels rater				Chicago rater				Antioch rater		
Group	A	B	C	Group	A-B	C-D	E-F	Group	A	B
I	x	x	x	I	x			I	x	x
II	x	x	x	II		x		II	x	x
III	x	x	x	III			x			
IV	x	x	x	I′	x					
				II′		x				
				III′			x			

The tabulation above (Table *B*) presents the situation in each school. In Table 4 are mean coefficients for each school, with its median. It is seen that the extent to which the Chicago teachers tended to agree was similar to that for the Fels raters, while the student teachers at Antioch were slightly less reliable. But on certain scales, they excelled the Chicago raters, notably *cheerfulness, competitiveness, emotional control, jealousy, obedience, quarrelsomeness, resistance.* Reference to Table 3 shows that these scales are among the generally most reliable scales, and it is to be supposed that the Chicago teachers would improve by further use here. The student teachers, by the same token, excel the Fels teachers on five of these scales, together with two others: *cruelty* and *leadership.* But the Fels coefficients here presented are not the coefficients most representative of the reliability of the scales; they are the coefficients secured from their first use in the Fels study. Subsequent experience with the scales improved the reliability for the scales generally. Such experience would presumably have a similar effect on reliability for the Chicago and Antioch groups. The fact of chief importance is that for some traits—those probably best defined, most objectively observed and evaluated in the nursery school situation—student raters are able to make fairly reliable ratings immediately. But for traits like *tenacity, sensitiveness, sense of humor, planfulness, physical apprehensiveness, originality, intensity of emotional response, gregariousness, friendliness, emotional excitability,* and *curiosity,* the student ratings are less reliable.

These data dealing with the use of the scales in other nursery school situations indicate that the reliability of the scales approximates that obtained in the Fels situation. We feel that the scales could be used with considerable accuracy in the usual nursery school, provided that the stated requirements of adequacy of observation, experience of rater, etc., were met.

V. USE OF THE SCALES IN SITUATIONS OTHER THAN NURSERY SCHOOLS

A. With Children of Six to Ten Years

We have had opportunity to use the scales in situations other than the nursery school to but a limited degree.

Eighteen of the scales were used for rating the behavior of a group of 30 school children (Grades 1-4) on the basis of two weeks' observation per child in a summer day camp. Reliabilities based on inter-rater correlations for the total group and corrected (Spearman-Brown) for the mean of three ratings as compared with comparable coefficients for the nursery school were as given in Table *C*.

TABLE *C*

	Day camp	Nursery school
Aggressiveness	.85	.91
Cheerfulness	.66	.88
Conformity	.74	.66
Emotional control	.67	.81
Emotional excitability	.65	.79
Frequency of gross activity	.76	.90
Friendliness	.77	.86
Gregariousness	.62	.85
Intensity of emotional response	.54	.76
Leadership	.79	.92
Originality	.69	.68
Patience	.73	.88
Planfulness	.76	.89
Sense of humor	.76	.90
Social apprehensiveness	.78	.88
Suggestibility	.46	.81
Tenacity	.69	.76
Vigor of activity	.79	.91
Median	.735	.870

Comparison of these columns shows that the scales used in the day camp with school children were considerably less reliable than when used in the nursery school. The coefficients are, on the average, .14 lower. In one case the reliability is greater (*conformity*), in one about the same (*originality*). But only one scale, *aggressiveness*, had a reliability coefficient of .80 or better. Nine scales had coefficients of .70 or better.

This material suggests that although certain of the scales are fairly adaptable to short observation periods for school children, they are, as a group, much less reliable than when used for longer periods (one month or more) in the nursery school.

B. Use of Certain Scales for Ratings in the Home

Two raters, one of the authors (M. K. Powell Simons, the nursery school observer), and the home visitor,[7] rated eight children of nursery school age on the basis of simultaneous observation of the child in his home, during a three-hour visit. The first rater had never before observed to any extent three of the children. The home visitor was well acquainted with each child because of previous home visits, but had never used these particular rating scales; she had, however, used scales of very similar design for rating parent behavior. Five scales were used, yielding the following correlations (Table *D*).

TABLE *D*

Scale	Home	Nursery school
Cheerfulness	.95	.83
Friendliness	.73	.88
Obedience	.68	.81
Resistance	.77	.91
Social apprehensiveness	.94	.89

These coefficients, raised for the average of two raters, are compared with those obtained on the basis of nursery school observation.

This brief data suggests that ratings in the home, at least for some traits, may be as reliable as when made in the nursery school. Such ratings, however, would presume rather intimate familiarity with the child by the home visitor.

C. Use of Certain Scales When Physical Measurements were Made

Three raters used some of the scales in connection with the physical, anthropometric and X-ray examinations of groups of from 5 to 13 children. The children observed by one pair of raters were not the same children as those rated when either of the observers paired up with the third rater. There is a wide age range, from 16½ months to 120 months. The following represent mean (r_p) correlations (uncorrected for numbers of raters); comparable coeffi-

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[7] Miss Mary Frances Hartson, who visits each home bi-yearly to rate parent behavior.

TABLE *E*

Scale	Physical examination	Nursery school
Curiosity	.38	.52
Emotional control	.61	.67
Emotional excitability	.60	.61
Intensity of emotional response	.60	.59
Obedience	.52	.68
Physical apprehensiveness	—.31	.58
Sense of humor	.62	.73
Suggestibility	.57	.70
Vigor of activity	.69	.72

cients for the nursery school situation are also presented (Table *E*).

On four of these scales—the three emotion variables, and *vigor of activity*—the coefficients are very comparable. On four scales—*curiosity, obedience, sense of humor*, and *suggestibility*—the nursery school ratings are perhaps understandably more reliable. In the case of *physical apprehensiveness*, the physical examination ratings are quite unreliable.

It should be mentioned that the raters in physical examination were not psychologists;[8] they knew the children well, however, and were familiar with the general task of rating characteristics in children.

These data regarding the utility of the scales in situations other than the nursery school are extremely meager, since they involve few cases in most instances. They serve to indicate, we feel, that at least some of the ratings may be made in the home, in physical examination and on older children with some degree of confidence. This presumes that the raters have adequate opportunity to observe. Whether the scales are as effective as would be scales designed more specifically for such non-nursery school situations is another question.[9]

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[8] Margaret Anderson, Katherine O'Brien Esselen, and Dorothy Snell Smith, M.D.

[9] Recent preliminary analysis of a new group of scales for school children which were used in the day camp period in the summer of 1940 indicates greater reliability than was obtained for some of the Fels Behavior Scales here described.

VI. VALIDITY OF THE SCALES

What the scales measure is a question difficult to answer. Some investigators have considered that a rating scale is self-validating; to the extent that the rater's execution of the rating approximates the task implied by the definition or description of the trait, his evaluation is, by definition, valid. Such a viewpoint presumes, clearly, that the rater has an intelligent understanding of the trait as defined. It also demands certain relevancy of the cues and some accuracy in their placement.

Another approach to validity can be made by correlating the scales with other measures, and with each other, since each scale is an independent measure.

A. INTERCORRELATION OF THE SCALES

Table 5 presents Pearson intercorrelations involving 40 cases, for 29 of the scales. (*Patience* was omitted, since, because it was the latest to be used, we had few cases rated on this scale.) Forty children were used in these intercorrelations.

Except where noted, mean scores of three raters were used for all correlations with other variables.

It will be seen that there are several high correlations. Besides certain single-coefficient clusters or doublets, such as the relations between *intensity of emotional response* and *emotional excitability* (.76), *planfulness and tenacity* (.76), *cheerfulness* and *sense of humor* (.79), *cruelty* and *quarrelsomeness* (.88), *suggestibility* and *jealousy* (—.74), there are three clusters of more or less prominence: one involves the scales of *vigor* and *frequency of activity,* and *fearlessness,* or the reverse of *physical apprehensiveness.* Apparently the vigorous, active child is considered less apprehensive. In the light of the age level and nursery school situation, it is likely that the tangible criterion of fear is an inhibition of activity. This interrelationship suggests a situation which probably obtains throughout the correlational matrix. The apprehensiveness variable deals with motivation, possibly, which to some extent underlies or is expressed by the overt activity.

A second large cluster involves *aggressiveness, gregariousness, leadership, competitiveness,* and the reverse of *social apprehensiveness*: poise or boldness. Correlated with these scales of social participation

TABLE 5

PEARSON COEFFICIENTS OF INTERCORRELATIONS BETWEEN 29 RATING SCALES

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Affectionateness	1															
Aggressiveness	2	.48														
Cheerfulness	3	.21	.21													
Competitiveness	4	.09	.67	.14												
Conformity	5	.24	—.25	.26	.08											
Cruelty	6	—.28	.53	—.08	.41	—.54										
Curiosity	7	.16	.46	.36	.24	—.11	.36									
Emotional control	8	.09	—.27	.36	.04	.72	—.44	—.09								
Emotional excitability	9	.04	.57	—.20	.30	—.49	.58	.37	—.81							
Fancifulness	10	.18	.40	.05	.07	.03	.18	.12	.06	.14						
Frequency of gross activity	11	.14	.71	.40	.38	—.20	.57	.65	—.27	.54	.07					
Friendliness	12	.54	.51	.60	.49	.28	.05	.53	.24	.05	.37	.47				
Gregariousness	13	.37	.81	.27	.69	.04	.46	.44	—.11	.45	.47	.64	.70			
Intensity of emotional response	14	—.04	.50	—.24	.50	—.31	.60	.29	—.52	.76	.23	.56	.03	.45		
Jealousy	15	.06	.46	—.36	.56	—.35	.47	.08	—.51	.60	.52	.19	.06	.40	.00	
Kindness	16	.39	.00	.33	.21	.67	—.44	.01	.57	—.45	.27	—.15	.63	.25	—.54	—.17
Leadership	17	.22	.74	.39	.81	.16	.26	.28	.12	.17	.56	.45	.73	.75	.23	.51
Obedience	18	.05	—.56	.15	—.27	.76	—.64	—.23	.71	—.64	—.24	.38	—.08	—.33	—.42	—.02
Originality	19	—.12	.37	.36	.63	.31	.12	.24	.38	—.18	.52	.20	.44	.38	.05	.02
Physical apprehensiveness	21	.13	—.54	—.46	—.41	.12	—.48	—.60	.07	—.31	.01	—.72	—.32	—.40	—.32	.00
Planfulness	22	—.22	.25	.42	.60	.45	—.01	.03	.46	—.27	.54	.07	.54	.29	—.06	—.01
Quarrelsomeness	23	—.13	.74	—.11	.46	—.56	.88	.37	—.56	.70	.18	.68	.06	.33	.67	.57
Resistance	24	—.19	.41	—.36	.36	—.74	.71	.00	—.68	.61	.26	.19	—.11	.31	.55	.73
Sense of humor	25	.00	.36	.79	.30	.03	.22	.35	.13	—.01	.20	.45	.62	.40	—.05	—.11
Sensitiveness	26	.31	.14	—.12	.48	.33	—.11	—.07	.07	.20	.44	—.04	.23	.27	.41	.54
Social apprehensiveness	27	—.19	—.72	—.36	—.39	.22	—.47	—.64	.24	—.48	—.35	—.66	—.60	—.67	—.26	—.14
Suggestibility	28	.11	—.45	.29	—.40	.60	—.56	.04	.51	—.47	—.38	—.11	.05	—.32	—.38	—.74
Tenacity	29	—.23	—.06	.37	.22	.46	—.22	—.08	.52	—.45	.11	.02	.13	—.08	—.15	—.20
Vigor of activity	30	—.13	.66	.42	.40	—.23	.64	.55	—.27	.50	—.01	.89	.38	.33	.49	.19
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

TABLE 5 (*continued*)

		16	17	18	19	21	22	23	24	25	26	27	28	29	30
Affectionateness	1														
Aggressiveness	2.														
Cheerfulness	3														
Competitiveness	4														
Conformity	5														
Cruelty	6														
Curiosity	7														
Emotional control	8														
Emotional excitability	9														
Fancifulness	10														
Frequency of gross activity	11														
Friendliness	12														
Gregariousness	13														
Intensity of emotional response	14														
Jealousy	15														
Kindness	16														
Leadership	17	.39													
Obedience	18	.42	—.20												
Originality	19	.40	.62	.07											
Physical apprehensiveness	21	.16	—.40	.30	—.34										
Planfulness	22	.38	.63	.23	.73	—.32									
Quarrelsomeness	23	—.44	.32	—.72	.08	—.55	—.07								
Resistance	24	—.52	.15	—.82	—.09	—.14	—.16	.69							
Sense of humor	25	.30	.50	—.11	.54	—.48	.39	.13	—.04						
Sensitiveness	26	.25	.28	.09	.16	.16	.23	—.02	.09	—.09					
Social apprehensiveness	27	—.15	—.51	.50	—.33	.56	—.05	—.52	—.19	—.53	.15				
Suggestibility	28	.38	—.25	.75	—.11	.07	—.03	—.60	—.82	.04	—.23	.17			
Tenacity	29	.28	.31	.43	.47	—.18	.76	—.22	—.57	.21	.14	.17	.17		
Vigor of activity	30	—.22	.39	—.42	.28	—.80	.22	.67	.27	.55	—.07	—.58	—.17	.07	
		16	17	18	19	21	22	23	24	25	26	27	28	29	30

are both *friendliness* and *quarrelsomeness*, though these are between themselves unrelated.

A third cluster involves *suggestibility, obedience, conformity, emotional control,* and the reverse of *resistance* and *cruelty*.

Multiple factor analysis (Thurstone), applied to this matrix of intercorrelations, yielded the pattern shown in Table 6, after rotation of three axes.

TABLE 6

FACTOR LOADINGS AFTER ROTATION AND COMMUNALITIES FOR TWENTY-NINE SCALES

Scale	No.	*I*	*II*	*III*	h^2
Affectionateness	1				.07
Aggressiveness	2	.64	.60		.82
Cheerfulness	3	.35	—.26	.70	.69
Competitiveness	4	.80	.31		.73
Conformity (non)	5		.74	—.32	.69
Cruelty	6	.23	.81		.71
Curiosity	7	.23	.29	.57	.46
Emotional control (non)	8		.79		.70
Emotional excitability	9		.83		.71
Fancifulness	10	.62			.43
Frequency of gross activity	11	.68	.52		.77
Friendliness	12	.71		.47	.74
Gregariousness	13	.70	.36	.29	.70
Intensity of emotional response	14		.71		.56
Jealousy	15		.69	.55	.79
Kindness	16	.52	—.61		.69
Leadership	17	.88			.84
Obedience (non)	18		.85		.74
Originality	19	.72			.57
Physical apprehensiveness (non)	21	.27	.37	.62	.59
Planfulness	22	.71	—.28		.58
Quarrelsomeness	23	.25	.89		.85
Resistance	24		.86		.80
Sense of humor	25	.44		.66	.63
Sensitiveness	26	.54		—.47	.51
Social apprehensiveness (non)	27	.35	.37	.72	.78
Suggestibility (non)	28		.73	.44	.75
Tenacity	29	.40	—.42		.33
Vigor of activity	30	.66	.53		.76

Inspection of these factor loadings suggests that Factor I has to do with desirability of behavior, in that desirable behavior at the nursery school level is mature behavior. The pattern of coefficients is quite similar to that for the correlation of the scales with chronological age (Table 7). But the pattern is also similar to that for the correlation of the scales with the Joël scale (Table 7), where age was partialled out by using the Behavior Quotient. A name

TABLE 7

CORRELATIONS OF TWENTY-NINE SCALES WITH CHRONOLOGICAL AGE, BINET *IQ*, MERRILL-PALMER σ SCORE, VINELAND SOCIAL QUOTIENT, AND JOËL BEHAVIOR QUOTIENT

Scale	Chron. Age	Binet *IQ*	Merrill-Palmer σ score	Vineland Social quotient	Joël behav. quotient
Affectionateness	—.16	.00	.06	.28	.23
Aggressiveness	.25	.18	.02	.21	.49
Cheerfulness	.07	.11	.07	.09	.32
Competitiveness	.61	.36	.27	.12	.58
Conformity	.22	.00	.34	—.27	.28
Cruelty	.00	—.08	—.08	.06	.08
Curiosity	.10	.08	—.29	.18	.26
Emotional control	.14	.10	.24	—.23	.11
Emotional excitability	—.32	—.02	—.21	.23	.17
Fancifulness	.51	.50	.53	.15	.49
Frequency of gross activity	—.08	—.09	—.15	.33	.31
Friendliness	.40	.15	.08	.18	.51
Gregariousness	.51	.02	.00	.04	.48
Intensity of emotional response	—.02	—.02	—.16	.22	.17
Jealousy	.51	.16	.14	.08	.26
Kindness	.43	.10	.05	—.04	.30
Leadership	.62	.41	.34	.20	.63
Obedience	—.09	—.01	—.07	—.28	—.08
Originality	.33	.22	.02	.07	.31
Patience	.14*	X	X	—.29	X
Physical apprehensiveness	.09	—.04	.00	—.30	—.27
Planfulness	.55	.26	.38	—.07	.41
Quarrelsomeness	.09	—.07	—.11	.15	.11
Resistance	.26	.11	.05	.31	.05
Sense of humor	.34	.14	—.02	.18	.24
Sensitiveness	.44	.15	.24	.07	.31
Social apprehensiveness	—.13	—.11	.19	—.23	—.24
Suggestibility	.09	—.11	—.21	—.16	—.05
Tenacity	.30	.20	.15	.03	.19
Vigor of activity	.18	—.17	—.08	.35	.27
No. of cases	(33-35)	37	26	40	32

*$N = 16$.

for this factor might be "desirability of behavior," or "maturity of behavior." It is similar, we feel, to the "desirability" factor indicated for the Merrill-Palmer Personality Rating Scales by one of us (9), and to a desirability factor suggested by Van Alstyne (11) for ratings of young elementary school children. A study by Williams (12) suggested a factor of "approach-withdrawal" for ratings on nursery school children, which factor seemed to us to be interpretable also as "sociability," perhaps, and thus somewhat similar to desirability and maturity.

Factor II in Table 6 seems to be one of independence or non-conformity, or even antagonism. It is in most saturation in *quarrelsomeness, resistance, disobedience, emotional excitability, cruelty, lack of emotional control, non-conformity*, etc. Its pattern is similar to that for the Vineland Social Maturity Scale (Table 7), which conceivably is a measure of social independence. We feel that Williams' ascendance-submission factor, the factor of ascendance for the Merrill-Palmer *Personality Scales,* and Van Alstyne's factor of social independence are similar in concept.

Since desirability in the case of Factor I and undesirability in the case of Factor II are rather apparent, it is probably important to consider the operation of halo effect. Whether halo effect would and does operate as a factor, or whether it could operate as two or more factors is difficult to state. It is also important to consider that halo may be an expression from the rater of a valid psychological concept identified at least at the nursery school level with maturity of behavior. Since maturity of behavior in the opinion of the nursery school rater is quite possibly to some extent increased sociability, we might expect a complex of desirability, sociability and halo to emerge as a factor. If this were the case, Factor I would be the most intelligible expression of it.

Factor III is of greatest amount in lack of *social apprehensiveness* ("poise"), *cheerfulness, sense of humor,* lack of *physical apprehensiveness,* etc. It might be called a mood factor, or an extroverted factor, with sensitiveness and independence at the nega tive end. It may be similar to the "surgency" factor describ by Cattell and Molteno (1). *Jealousy* is fairly saturated positive —more so, in fact, than is *gregariousness.*

We are not sure either that the third factor extracted is a re one, or that three factors are necessarily all that are significa With the sigma of the original correlation coefficients at ±.16,ne sigma of the residuals went from ±.26 to ±.11 to ±.07. Rotations involving a fourth factor seemed to help but little, however, in rendering the factor matrix more intelligible. The safest conclusion would be that we have evidence of two factors, relating to desirability and good adjustment on the one hand, and to antagonistic behavior on the other. A third factor possibly emerged as a mood or extroversion-introversion factor.

Obviously, the scales as a group overlap greatly. In terms of h^2, or the proportion of the variance of the scale which is shared by the first three factors, it is seen that for four variables 80 per cent or more of the variance is shared with other scales; for only four scales is less than 50 per cent shared. These four most unique scales are *affectionateness* (8%), *tenacity* (33%), *fancifulness* (43%), and *curiosity* (46%).

These data indicate that the scales represent measures from different angles of the same things. But they indicate something of the validity of single scales (to the extent that they do overlap) if only because the nature of each scale is defined in terms of those correlated with it. The coefficient of .89 for *frequency* and *vigor of activity* indicates that the traits are not independent—but this is some assurance that we are rating what is common to both definitions: physical activity. And the high negative correlation of these traits with physical apprehensiveness suggests that the latter trait is evaluated in terms of lack of participation, while the activity traits are evaluated partly in terms of non-hesitancy to participate.

Suggestibility and *obedience* and (non) *resistance* and *conformity*, and possibly *emotional control* would be expected to correlate if they are valid and reliably measured: they do. *Cruelty* tends to correlate with these negatively, suggesting that part, at least, of what we define as cruelty has to do with the degree of non-conformity of the child's behavior, or that perhaps the cruel child is obviously nonconformed. But *cruelty* as judged is practically identical with *quarrelsomeness*—also a non-conformist trait.

In order to determine to some extent the overlapping of the scales with external criteria of mental status, social maturity, and with maturity itself, Pearson coefficients were calculated for each scale and the following: chronological age, Stanford-Binet *IQ*, Merrill-Palmer sigma score, Vineland Social Maturity Quotients, and Joël Behavior Maturity Quotients. These coefficients are presented in Table 7. Chronological age was calculated at the mid-point of the child's period in nursery school. The mental tests and the Vineland data were obtained at the birthday or half-birthday nearest to the child's nursery school period. (In some cases these scores were interpolated.) Of these five external variables, only the Joël Quotient was rated by the same raters and at the same time as the ratings on the 30 Fels Behavior Scales. The Joël Quotients are the result of pooled judgments of the raters.

Regarding the correlations of the scales with chronological age, it should be pointed out that there was a range in age for the population from 25 to 75 months, with mean and sigma for 37 cases at 44±13 months. The traits which are related to age are traits associated with mature social behavior or with mature intellectual behavior and are heavily saturated with Factor I (Table 6). Except for jealousy (the chief component of which may be social awareness), there appears to be no relation between maturity (*Gd*) and those traits we have considered to be emotional.

The mean Stanford-Binet *IQ* for the group used in correlation with the scales was 119, with a sigma of 15 points. Forms *L* or *M* of the 1937 Revision were used. Although coefficients of correlation between the mental tests and the behavior scales are not high, there is a sensible pattern to them. Coefficients above .25 were as follows (Table *F*).

TABLE *F*

	S-B	*M-P*
Fancifulness	.50	.53
Leadership	.41	.34
Planfulness	.26	.38
Competitiveness	.36	.27
Conformity	(.00)	.34
(Non) curiosity	(—.08)	.29

A pattern of mental maturity clearly emerges. *Leadership* and *competitiveness* imply intelligent behavior, and *fancifulness* and *planfulness* suggest to some extent a creative quality.

The group used for the correlations of the scales with the Merrill-Palmer Scale was smaller and 10 months younger than the group which received the Stanford-Binet. It is seen that those scales with which the Stanford-Binet tends to be related also correlate to some extent with the Merrill-Palmer Scale. But the Merrill-Palmer has a strange, though low, negative correlation with *curiosity*, and a positive correlation with *conformity*. Are these coefficients large enough to suggest any real difference between demands made upon the child by the two mental tests? Two traits which we had considered somewhat intellectual in character—*originality* and *tenacity*—correlate with the Stanford-Binet *IQ* .22 and .20, with the Merrill-Palmer .02 and .15.

On the whole, there is little relation between the 30 behavior scales and intelligence as measured during the nursery school period by the new Stanford-Binet and by the Merrill-Palmer scale.

The Vineland correlations were done on the 1939-40 group of children, while practically all others were done largely with the 1938-39 group. Correlations above .22 give a very interesting pattern (Table *G*). Here is an intelligible picture of independence, action and reactivity, decreased inhibition, a picture of a child whom Doll (5) would probably agree is socially mature. Doll proposes, in measuring social maturity, "to measure the extent to which the person progressively dominates his environment and creates, demands, or justifies his own freedom of action as age increases." *Aggressiveness* correlates .21, *leadership* .20, but *gregariousness* correlates .04, *kindness* —.04, *cruelty* .06. *Sociability*, generally, is not a part of the picture here developed. This pattern is similar to the configuration of scales correlated with Factor II, in Table 6.

TABLE *G*

Vigor of activity	.35
Frequency of activity	.33
Resistance	.31
(Non) physical apprehensiveness	.30
(Non) patience	.29
(Non) obedience	.28
Affectionateness	.28
(Non) conformity	.27
Emotional excitability	.23
Emotional (non) control	.23
(Non) social apprehensiveness	.23
Intensity of emotional response	.22

The Joël as used here was the short form, described by one of us earlier (8). It is constructed so that the child old for his age in certain characteristics—toilet training, removing wraps, washing, perseveration in play, social level of play, sportsmanship, dependence and leadership—receives a high total score and behavior age, and correspondingly, a high behavior quotient. Although the quotient was used for these correlations, it would be expected that *mature* nursery school behavior as determined by chronological age correlation would correlate with the scale. The pattern of coefficients above .25 for the Joël is as follows (Table *11*):

TABLE *11*

Leadership	.63
Competitiveness	.58
Friendliness	.51
Aggressiveness	.49
Fancifulness	.49
Gregariousness	.48
Planfulness	.41
Cheerfulness	.32
Frequency of activity	.31
Originality	.31
Sensitiveness	.31
Kindness	.30
Conformity	.28
Vigor of activity	.27
(Non) physical apprehensiveness	.27
Jealousy	.26
Curiosity	.26

This pattern is strikingly like that of Factor I in Table 6 and like the pattern of correlation with *CA* in Table 7. We have suggested that Factor I is very possibly one of halo effect. Since the teachers rated the Joël as well as the traits of the behavior scales, it is logical to suppose that the picture above is at least in part one of desirability of behavior. The "desirability" of the behavior pattern makes it no less real, however. We can conclude that the Joël measures a constellation of traits very close to that provided by maturity itself (at this age level), and that the scales forming this constellation hang together to give a picture of desirable social behavior very real to the nursery school teacher.

VII. SUMMARY

We have described in this report the development of 30 scales for use in the measurement of behavior at the nursery school level. Study of agreement between raters who used the scales indicated that they possessed greater reliability than is usually the case with rating scales. Although most reliable in the nursery school situation, there were indications of reliability at least of certain scales in other situations and for older children.

Because they intercorrelate highly, at least in some aspects, they appear to measure certain common areas. Three of these seem to be desirability of maturity of behavior, antagonism or aggression, and possibly an area of mood, or of introversion-extroversion.

The scales have little relationship singly to certain measures of mental and social maturity. Patterns of relationship to these scales were highly intelligible, however, and suggest real validity in the use of the scales as a group.

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MEASUREMENT OF THE SIZE OF GENERAL ENGLISH VOCABULARY THROUGH THE ELEMENTARY GRADES AND HIGH SCHOOL*

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I. INTRODUCTION

Measurement of vocabulary has long interested psychologists because in addition to its own importance it is closely related to other psychological abilities. The rôle of vocabulary measurements has been particularly important in the measurement of general intellectual ability. Terman (7) found that the vocabulary list of the Stanford Binet correlated more highly with the results of the total test than did any three other items combined. Moreover, a list of the vocabulary tests available would be to a large extent a list of intelligence tests of which the vocabulary test is a part. We have also assumed that vocabulary bears a close relationship to the reading skills and Seashore, Stockford, and Swartz in a study on college students (5) have shown that although size of vocabulary shows no correlation with speed of reading, the number of words a person knows does correlate highly with reading comprehension.

Measurement of the size of vocabulary is not new; many estimates for different age levels have been made. However, there has been wide disagreement among these studies. The work of previous investigators has been summarized by Seashore and Eckerson (4) in a table of the size of the vocabulary from first grade through college and adult years. Some work has also been done on the pre-school level. Smith (6) constructed a vocabulary test from a sampling of Thorndike's list of 10,000 most frequently used words and from recorded vocabularies of children. She tested children between the ages of eight months and six years, using pictures and questions to elicit the use of the word itself by the child or a definition of the word. She found a range in vocabulary size from no words for the eight months old child to 2,562 words in the vocabulary of the average six-year-old, the children showing an average gain of 572 words a year.

McCarthy (3) recorded a sampling of 50 consecutive responses for children from 18 to 54 months of age. She found the total number of words used at 18 months was 20, which number increased to 230 at 54 months of age.

Smith's work is to be criticized upon the basis of the inadequacy of her testing sample, which by the nature of the test imposes an upper limit to the possible scores. Also, the criteria of knowledge which she used were too inflexible to measure the child's knowledge of the words presented.

McCarthy was interested chiefly in the nature of the words and sentences used by the child rather than the extent of vocabulary and actually measured only a partial use vocabulary. Thus her results are *not* to be taken as a measure of the complete extent of the child's vocabulary.

Among the principal factors which have brought about major variations in the estimated size of vocabulary are, first, the continual growth of the English language; second, the definition of the unit of measurement, a word; third, the criteria of knowledge employed; fourth, and by far the most important, the basis for sampling, e.g., the size of the dictionary or the nature of the use situation from which the sampling for the test has been taken. Consequently, estimates of the size of vocabulary made on the basis of counts of words employed in some writer's works or counts of words used in conversations are inadequate as estimates of total vocabulary. Likewise a vocabulary test which is based on too small a sampling of words in the English language is inadequate. A test which is based on a pocket-dictionary automatically limits its sampling to only a portion of the total number of words available. Seashore and Eckerson's table (4) shows clearly that the larger the dictionary used as a basis for a sampling, the larger the estimated vocabulary will be. Hence we can surmise that past estimates of the size of vocabulary, based on dictionaries smaller than the unabridged volumes now in use, have been too small. Seashore and Eckerson (4), in fact, have shown that the number of words which the average university student knows is much greater than previous studies have indicated, averaging about 156,000 words for undergraduate students.

In the light of the variety of methods used and the results obtained it is well to consider the major variables of the measurement of vocabulary.

II. MAJOR VARIABLES

A. DEFINITION OF A WORD AS A UNIT OF MEASUREMENT

First, we need to define the unit with which we work, the word. We shall define a word as, "a dictionary item," as Seashore and Eckerson (4) have defined it in the construction of their vocabulary test. They make the distinction between "basic" and "derived" terms. Basic words are those which in the dictionary are printed in heavy type as separate entries along the margin. Derived terms are compound terms or words formed from the basic word, "usually listed in medium type and indented under the basic term" (4). For example, "*loyal*" is a basic word, "*loyalize*" and "*Loyal Legion*" are derived terms. Neither additional meanings for a word nor variant spellings are counted as separate words, but the same stem used in different parts of speech, when listed separately, and compound terms are counted as separate words under such a definition. The dictionary seems to follow the practice of listing separately different forms of the same word when *in that part of speech* it has a meaning not clearly indicated by the ending added to the word, e.g., "*fixing*" in the meaning of a dye chemical is listed separately from the verb "*fix.*"

On the other hand, Thorndike (8) would classify as variations of the main word all words which are:

a) plurals, *s* or changing *y* to *ies*
b) Adverbs, *ly*
c) comparatives and superlatives, *er* and *est*
d) verb forms, *s, d, ed, ing*
e) past participles adding *n*
f) adjectives, adding *n* to proper nouns

This definition of Thorndike's gives fewer "words" in the language than Seashore and Eckerson's definition, but many more, perhaps 50, types of variations could also have been included which would decrease the number of separate words still more.

Table 1 shows a comparison of the number of words on sample pages of Funk and Wagnalls *New Standard Dictionary* (unabridged) as counted according to Thorndike's definition and as classified by Seashore and Eckerson (4). The average number of "words" as counted according to Thorndike's definition is 77 while the number of words as counted according to Seashore and Eckerson's definition of a basic word is 60. Thus, a statement of the

TABLE 1

COMPARISON OF THE NUMBER OF WORDS IN FUNK AND WAGNALLS *New Standard Dictionary* ACCORDING TO DEFINITIONS BY THORNDIKE AND BY SEASHORE AND ECKERSON

		Seashore and Eckerson Units		
Vol. I Page number	Thorndike Units Number of words	"Basic" Marginal words in heavy type	"Derivatives" Other parts of speech	Compound words
101	77	70	17	33
201	39	34	11	112
301	52	58	6	95
401	86	40	27	91
501	59	62	11	36
601	45	55	9	97
701	44	38	16	32
801	88	40	22	50
901	54	49	19	67
1001	134	89	45	19
1101	152	107	15	28
1201	116	53	39	27
1301	146	47	43	58
1401	49	67	6	16
Totals	1141	809	286	751
Ave. Vol. I	81.4	57.7	20.4	53.6
Ave. Vol. II	73.5	62.9		
Ave. I + II	77.4	60.3		
x 2757 pages in dictionary	213,392	166,247	56,243	147,775

size of vocabulary in terms of basic words appears to be a conservative estimate. On the basis of this sampling of the dictionary it would seem that vocabulary in terms of Thorndike's units is about 25 per cent larger than the basic vocabulary measured by Seashore and Eckerson, and about 42 per cent smaller than their total vocabulary. In other words, basic vocabulary scores from the Seashore-Eckerson test may be converted approximately into Thorndikean units by multiplying them by 1.28.

B. CRITERIA OF KNOWLEDGE

Criteria of knowledge which may be applied to vocabulary are: (*a*) recognition of the commonest meaning of a word, (*b*) definition in the subject's own words, (*c*) use of the word in a sentence or citing an illustration.

C. RELATIVE VS. ABSOLUTE SIZE OF VOCABULARY

We may make a distinction between size of vocabulary as reported in absolute and in relative terms. By "absolute" we mean the total number of words in one's vocabulary as estimated from a representative sampling of all the words in a dictionary. By "relative" we indicate the size of one's vocabulary in relation to the vocabularies of some group of persons. The absolute vocabulary may not be known for a single person in the standard group, but the size of vocabularies are known in relation to each other. In indicating the size of a person's vocabulary by this second method we often make use of such approximations as quartiles, deciles, and centiles which have been derived from the standard group.

It is possible to measure size of vocabulary in terms of how many words an individual knows on an arbitrarily selected list in comparison with the number of such words that other individuals know. Gansl (1) preferred to use such a relative score rather than to try to measure the absolute size of vocabulary in thousands of words, since so many different results had been obtained in absolute measurements prior to the publication of Seashore and Eckerson's analysis of the factors involved in such measurements. She was interested in the growth of vocabulary through elementary school and a relative score served her purposes fairly well, although short samplings from limited sources may impose an artificial upper limit in scores.

Secondly, we may get an absolute score, an estimate of the actual number of words in the vocabulary. For this purpose the test used must not only be reliable, but must be made from a large enough sampling of the words in the English language to give the best person tested a chance to show all he knows.

There is need for having some idea of absolute size of vocabulary at the elementary and high school levels. Knowing the number of words which an individual can use correctly gives some idea of the breadth of his information and of his intellectual tools.

Since children's books for the lower grades especially are being built around carefully controlled reading vocabularies and introduce only a limited number of words per book, it will be significant to know how many words the beginning pupil may be expected to know and how many words he normally will add to his store in a year's time. To be sure, this limiting of the number of words introduced to the child as he is beginning to learn to read is a good teaching device from the point of view of mastering a technique. There is a great discrepancy at the first grade level between the number of words which the child *can read* and the total number he can *recognize when spoken*. There probably are several different vocabularies such as reading and pronouncing, or reading and comprehending, as well as general comprehension vocabulary. In later grades, even when reading vocabulary has increased spelling vocabulary is still rather limited.

It is a problem for future research as to when and how these discrepancies disappear, for Seashore and Eckerson (4) have shown that at the university level there is little difference in the size of vocabularies as measured by any of the three criteria of knowledge. Individuals were able to use and illustrate about 92 per cent of all the words they could recognize.

We are interested not only in the nature of the growth of the size of vocabulary through the school years, but also in an estimation of the actual number of words which children of those ages can use. An absolute measurement in terms of the total number of words known can also be translated into relative terms such as centiles, deciles, and quartiles.

The test used in this study was the *English Recognition Vocabulary Test*[1] by Seashore and Eckerson (4). It has several advantages for our purpose of securing absolute scores. First, it was constructed from a sampling of Funk and Wagnalls' *New Standard Dictionary of the English Language*, two volume edition of 1937, one of the largest available at that time. Second, the items in the main part of the test are presented in a multiple-choice form which meets the criterion of knowledge as recognition of the commonest meaning of the words. Third, words in the test are arranged in order of difficulty which allows for testing on only the first part of the test with the younger children. The scoring formula of the test permits an estimate of vocabulary size from whatever number of words an individual has attempted to define.

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[1] Published by the authors, Evanston, Illinois.

III. PURPOSE AND PROCEDURE

A. PURPOSE

1. To determine the criteria of knowledge and the procedures necessary for measuring the absolute size of vocabulary among subjects below college level and particularly at the lower ages.
2. To employ these procedures in determining the individual differences in size of vocabulary over the range from first to twelfth grades inclusive.
3. To determine the central tendencies and variabilities of these measurements for a description of the growth of vocabulary during this period.
4. To provide tentative norms in the absolute size of vocabulary for this range of age and grade levels.

B. PROCEDURE

The *English Recognition Vocabulary Test* by Seashore and Eckerson (4) was given to pupils from first grade through high school in two schools[2] and through the first eight grades in a third school.[3]

There are three parts to this test. The first part consists of 173 multiple choice items made up of basic general terms, arranged in approximate order of difficulty. The second part contains 158 words which are either proper nouns or rare words. These words are compactly printed in four columns and from this number the student is expected to choose those few words which he knows and to write definitions for them. The third part has 46 "derived terms," that is, variations in parts of speech as well as compound and technical terms, also arranged in order of difficulty. For part three as well as in part two the subject must write out the meaning of the words. Since relatively few words are ordinarily known in parts two and three of the test, this written portion of the test is rather brief.

For adults the test may be used as either a speed test or a power test. For work with children and especially in investigating the absolute size of vocabulary, it is necessary to use the test without time limits, as a power test.

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[2] New Concord-Union Rural School, New Concord, Ohio, tested Dec. 10, 1939, to Jan. 5, 1940, and Northbrook Public Schools, Northbrook, Illinois, tested Feb. 5, 1940, to March 5, 1940.

[3] Cleveland Public School, Niles Center, Illinois, tested March 6, 1940, to April 3, 1940.

In order to measure absolute size of vocabulary the method of testing must be adapted to the purpose at hand which is to ascertain *for how many of the words in the test-sampling the child knows some correct meaning.* It would be relatively easy to adopt one criterion of knowledge and to measure the children's performance upon the vocabulary test in accordance with that criterion and thus secure rankings in vocabulary ability. However, in measuring absolute size of vocabulary we do not want mere rankings; we desire an adaptable measuring method which will allow the child to show what he knows about the words in the test. This means the eliminating as far as possible of the influence of such factors as the child's ability to read and to spell, because we are interested only in measuring the number of words for which the child has some effective knowledge and not in his expression of that meaning.

Preliminary testing indicated that a combination of several criteria of knowledge would best accomplish this purpose, especially in testing at the lower elementary levels. In fact, there is an increasing stringency of the criteria of knowledge of a word with increase in the chronological age of the subject. This difference in criteria at the two age levels cannot be equated or legitimately ruled out except through individual testing throughout the grade range, because children simply do improve in both the quality and the quantity of words known. It was our purpose to discover those methods of testing at the different grade levels which would give the most accurate picture of the growth of vocabulary.

Preliminary tryouts showed that there were three main administrative groups into which the subjects fell: (*a*) Early elementary, grades one, two, and three; requiring individual, oral testing. (*b*) Middle elementary, grades four, five, and six; requiring aid in reading. (*c*) Late elementary and high school; requiring only opening directions and occasional supervision and aid in reading. However, the change from one method to another in testing different grade levels is gradual and adaptations for exceptional individuals must be made at all levels.

In late elementary and high schools the test was administered to groups of from 25 to 40 students. The examiner always introduced the work by telling the students that the test was part of a study which was for the purpose of finding out how many words high school and grade school people knew. They were assured that the results of the test would have no bearing on their school grades. The high school testing was done mainly through English classes. They were told the test was one which could be used from first grade through college; that, accordingly, it began with easy words and gradually became harder. They were cautioned against carelessness on the easy words and encouraged to guess on any words which seemed at all familiar.

After the students had filled in the data on the front of the test, they were asked to open the booklets; were shown the example at the top of the page; and permitted to start work. The examiner encouraged them to attempt all words they knew, by saying, *"It is a good idea to guess. If you don't know a word at all, leave it out, but if you can make a good guess, be sure to try the word."* The examiner also offered to define any of the words used in the multiple choice responses and to pronounce any of the words. The students were told, *"If you don't know what one of these words in light type means, ask and I will tell you. If you want any word pronounced, ask and I will pronounce any of the words for you."*

The examiner then made it a point to move among the seats and to make sure that each student was following directions as to the placing of the numbers. This also afforded the students an opportunity to ask any questions they might have.

When the first several pupils had completed part one, the examiner asked for the attention of all of the group. The words on part three were pointed out, their nature explained, and directions for writing out the definitions given. The examiner said, *"The words in part three are compound and technical words. You are to write out what they mean. Be sure to write a full explanation or description; tell enough so someone else could tell just what you mean. For example, number one is 'for mercy's sake'. Just explain what you mean when you say, 'for mercy's sake'. Write the meanings for as many of the words as you can."*

A little later the group as a whole was shown part two and given these instructions: *"Part two has words which are rare or which are the names of places and people. You are to write out what the words mean for as many words as you can. Since there are so many words you might notice particularly these words. Check the ones you know and then write out the meanings when you are ready."* (Here the examiner read the number and pronounced the word for 27 of the words.) *"You may write out any other words you know, too. Finish part one and part three, and then do part two."*

The test was administered in classes which had 50 to 45 minute periods. Those students who did not finish in one period were given an opportunity to complete their papers at the next meeting of the class.

The first part of the test was scored on the basis of the number of words which the pupil attempted to define. From the number attempted was subtracted the errors corrected for guessing and the resulting score was multiplied by a constant which gave the number of basic words known. Scores on parts two and three were the number of words correctly defined multiplied by constants. In scoring parts two and three credit was given only for definitions which indicated the meaning of a compound term *as a whole* and not definitions of the separate parts. Half-credits were used liberally. The sum of these three scores represented the total vocabulary.[4]

In the middle elementary grades, four, five, and six, the children were given the same introductory remarks as those used for the high school. In addition the examiner said, ". . . *We will work together. I will read the words for you. Now the first word in dark type is 'adhesive.' If adhesive is 'slippery' put a 1 in front of it. If adhesive is 'rough', put a 2 in front of adhesive. If adhesive is 'fatty' put a 3 in the parenthesis. Or if adhesive is 'sticky' put a 4 in front of adhesive. Now don't say anything about the words; just mark it.*" After making sure that each child was marking this word correctly, the examiner continued. *"The second word is 'quick.' Does quick mean the same thing as 'dead'? Does quick mean 'fast'? Does quick mean 'good'? Or does quick mean 'slow'? Put the number of the word that means the same thing as quick in front of quick."* Then with less elaborate questions, the examiner continued to read each test word, repeating the word to be sure each pupil heard correctly and then read, in order, the four possible answers, avoiding cues from the voice. Whenever the children requested them, definitions for the choice words were given.

Standard definitions had been written out before the work of testing began, so that the examiner furnished the same answers whenever requested for a definition. On certain items, the examiner

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[4] More detailed scoring directions are printed on the test blank and are discussed by Seashore and Eckerson (4).

did not wait for the children to request definitions, but incorporated them into her original question, as: "Number 14, takedown. What do we mean by takedown? Does takedown mean reputation, that is what people say about you? Or does takedown mean lowering? Is takedown, celebration? Is takedown, honors?"

The range in difficulty of the words in this test is so great that the last page contains words which are almost all too difficult for pupils of the fourth, fifth, and sixth grades. In addition, since the alternative responses for the more difficult items were so chosen as to test a college student's ability to distinguish the correct meaning from those which were fallaciously similar in sound, spelling, etc., younger students may obtain somewhat *less than chance* scores on this portion of the test when items on the last pages are marked blindly. This is an instance of a further qualitative difference in the nature of vocabulary knowledge at different ages.

Consequently it is wise to suggest to the children that they leave out any words on pages three, four, and five which they have never seen nor heard before. In general, fourth and fifth graders should attempt at least 100 words; sixth, seventh, and eighth graders at least 110 words. The specific words which the examiner should urge the children to attempt are listed in the manual for upper elementary grades.[5]

There will be children who will mark all the items in the test regardless of instructions. Any child who wants to should be allowed to mark the items in order to avoid penalizing the best students. However, in the scoring only the designated 100 or 110 words should be considered unless it is found that the score based on the entire test is higher; in this case the higher score is taken as the one representative of the child's knowledge.

For parts two and three the children in grades five and six were requested to write the meanings of the words as in the upper grades.

In grade four additional precautions were taken. Only four to six children were tested at a time on part one, in the manner described. And for parts two and three, each child was taken individually. The examiner gave the child an unmarked test booklet and then asked the child to define the words on parts three and two. The examiner wrote the child's reply as he gave it, encouraged him to attempt all the items he could, and asked whatever questions were necessary to clear up ambiguous replies.

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[5] This manual may be secured from the author.

In addition, the children were told that some of the words in part one had two meanings and that for some of them the examiner wanted examples. The examiner then asked the child to give examples, to use in sentences, and to define in his own words, and in some cases to give additional meanings for those words which the child had marked incorrectly, but which most third grade pupils could define. Similar follow-up questioning was used with certain fifth and sixth graders who had missed words which children in the first three grades answered correctly.

In grades one, two, and three the children were tested individually. The examiner asked the child to define the word. If the child could not reply at once or if he did not make his meaning clear, the examiner read the choice words. Preliminary try-outs showed that these four alternative responses if read in a series made too great an amount of material for the child's memory span. The younger child could not comprehend such a complicated question. For this reason the alternative responses were phrased in separate short questions which repeated the test word with each alternative response. These could be read one right after the other without exceeding the child's memory span. The questions which were used by the examiner were prepared in a manual and kept standard for each child.[9]

In some instances the child's initial response to the word alone was incorrect, but when the alternative responses were presented he corrected his first response and chose the correct answer. In this case he was given full credit for the word, allowing of course for chance.

The child sometimes gave stereotyped answers to the alternative responses on the basis of position cues; that is, he would always choose the last of the four alternative responses or the first, without regard to their meaning. In such a case or if the child did not respond to the multiple-choice question at all, he was asked to describe the object in his own way or to tell something about it, or to use the word in a sentence and then to explain his sentence. If his reply to such questions was correct the choice of an incorrect alternative response was disregarded and he was given credit for that word.

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[9] This manual may be secured from the author.

When all other questions failed, leading questions were asked and only half-credit was given for correct replies to such questions.

For all of the words, any correct meaning which the child could give was credited. For some words the child might choose the wrong alternative responses or say that he did not know the word and yet be able to define the word correctly in terms of another meaning, in which case he was given full credit. For example, the child might not know "poker" as a game, but know it as a fire-tool.

IV. RESULTS AND DISCUSSION

Since there are two common conceptions of a "word," the scoring of the vocabulary test is arranged to allow for analyzing the results into terms of either basic words alone or of total vocabulary which includes both basic and derived terms. The results then may be quoted in those terms which fit the reader's preference in the definition of a word.

Before examining quantitative differences it is well to remember that the qualitative criteria of knowledge becomes increasingly stringent with progress through the grades and that to this extent the scores are not strictly comparable. However, one would scarcely expect the quality of meanings to be the same at widely different ages and no statistical allowances would seem to be called for. It is simply an observed fact that vocabulary grows both qualitatively and quantitatively.

Figures 1 and 2 show the means, quartiles, and range of the basic and total vocabulary scores for grades one to twelve inclusive.

The number of pupils tested were: 44 in first grade, 40 in second,

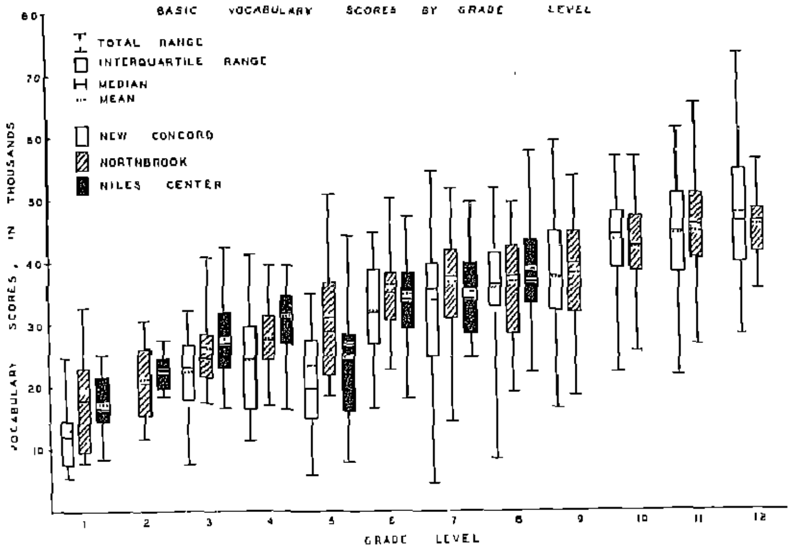


FIGURE 1

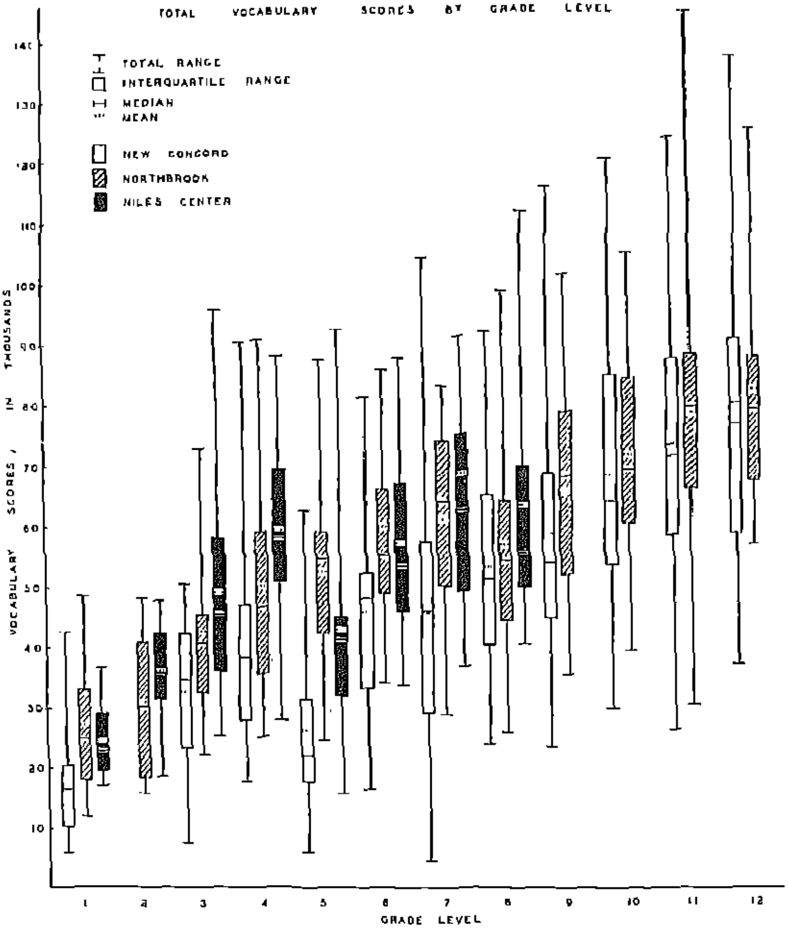


FIGURE 2

59 in third, 73 in fourth, 61 in fifth, 66 in sixth, 69 in seventh, 71 in eighth, 114 in ninth, 111 in tenth, 95 in eleventh, and 64 in twelfth grade; making a total of 867 pupils tested.

It will be noted that the average size of vocabulary whether analyzed for basic words alone or by a total score including derived words is numbered in the tens of thousands. When we give the child an opportunity to show what he knows about an adequate sampling of words and avoid restricting his performance by inadequate testing methods or by a sampling which imposes an artificial ceiling the child gives evidence of knowing a great many more words than we have hitherto estimated that he knew. Absolute size of vocabulary throughout the grade distribution greatly exceeds past estimates.

One of the striking characteristics of these distributions is the variability in scores within one grade. The range of individual differences in raw scores, especially for the total vocabulary is very great. Table 2 gives the percentage of variance (one-half the interquartile range, or Q, divided by the mean) of the scores within each grade. With the exception of the fifth grade, the percentage of variance is greater for the total vocabulary scores than for basic vocabulary.

TABLE 2

PERCENTAGE OF VARIANCE (Q/M) OF SCORES IN EACH GRADE FOR BASIC AND TOTAL VOCABULARY SCORES

	New Concord			Northbrook			Cleveland Niles Center		
Grade	Basic	Total	N	Basic	Total	N	Basic	Total	N
1	26	27	(13)	21	28	(19)	20	20	(12)
2				26	36	(18)	11	15	(20)
3	20	29	(17)	13	15	(25)	16	23	(16)
4	27	23	(18)	12	24	(25)	12	16	(30)
5	29	26	(21)	24	16	(22)	25	15	(18)
6	19	21	(22)	11	15	(25)	13	18	(19)
7	23	31	(29)	15	20	(21)	16	19	(19)
8	12	24	(29)	19	17	(22)	13	16	(20)
9	17	20	(70)	17	20	(44)			
10	10	38	(64)	10	17	(47)			
11	14	20	(61)	11	14	(34)			
12	16	20	(42)	8	12	(22)			

It will be noted, too, that there is great over-lapping of scores from one grade to another. The over-lapping of basic vocabulary scores is so great that only grades one and two are completely outside the total range of individual differences in grade twelve. This is true only if the grades are compared within any one school system. Comparing all the schools together there is over-lapping of even grades one and twelve. Within any one school system the highest first and second graders knew more basic words than did the poorest student in every other grade level up to and including the eleventh grade! In the scores for total vocabulary the over-lapping is as great. The twelfth grade's lowest score exceeds the highest scores in only first and second grades in the Northbrook School, while first and twelfth grades overlap in the New Concord School. However, in the Cleveland School the highest first grader does not equal the lowest eighth grader in total vocabulary scores although the two grades overlap in basic scores; such fluctuations are, of course, greatly influenced by a few extreme scores.

This extreme overlapping is reduced somewhat when we compare quartiles rather than total ranges. In scores on basic vocabulary, Q_1 of the high school seniors exceeds Q_3 of the first six grades, while Q_1 of the eighth grade exceeds Q_3 of the first three grades. It is much the same for total vocabulary; Q_1 of the eighth grade exceeds Q_3 of only the first two grades, while Q_1 of the high school seniors is higher than Q_3 of the seventh grade in the New Concord and of the sixth grade in the Northbrook School. *It seems we have underestimated the ability of our better students and overestimated the ability of the poorer students all through the school.*

There is a progressive growth in the average size of vocabulary from grade to grade although the rate of increase is not very regular. Gansl (1), who measured relative size of vocabulary from grade three to eight inclusive, found that "the age-progress curve for vocabulary in this age range is best described as a straight line, with a slight tendency toward negative acceleration between the ages of twelve and thirteen." This description does not fit our results very well. The nature of her sampling of test words was such that the negative acceleration at grades seven and eight may be due to an artificial ceiling in the test. Also, her test was given as a written group test at all ages, which would introduce other factors into the results in addition to vocabulary knowledge.

In Figures 1 and 2 it can be seen that in the two schools New Concord and Cleveland, the mean for the fifth grade fell below the mean for the fourth grade. This is not true of the fourth and fifth grade scores of the Northbrook School, although there too, the difference in the two means is not as great as the difference in the means of most other two adjacent grades. There may be several reasons for this discrepancy.

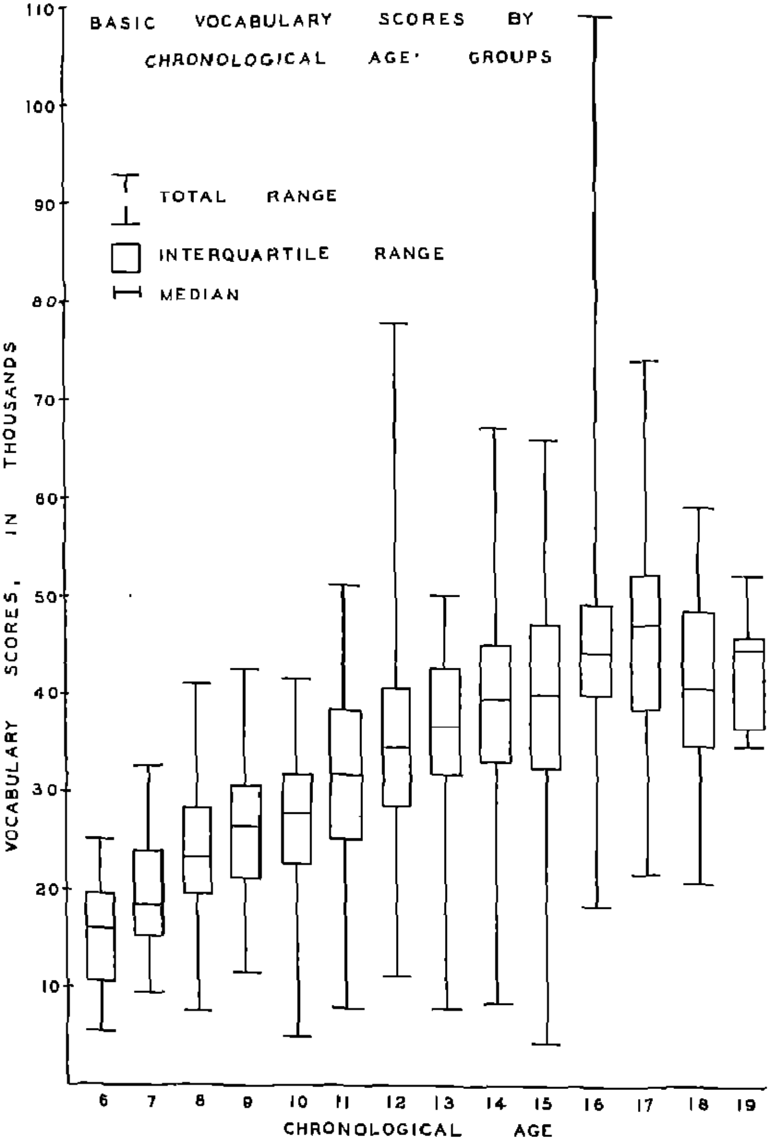
One obvious explanation would be a difference in the ability of the children. At Northbrook and Cleveland Schools the two grades were given the Kuhlmann-Anderson group test and the mean *IQ* scores for both grades were slightly over 100. Likewise the Stanford Achievement Test scores from the Cleveland School show the fourth and fifth grades both to be above their grade norms, the fifth a little more so than the fourth. For these two schools at least there is apparently no difference in the general intellectual ability of the children. At New Concord no intelligence or achievement scores were available, though the fifth grade contained many more repeaters than the fourth did and it was the feeling of the principal of the school that the fourth grade was a superior group for that school.

Another explanation may be in the change of the method of administration of the test at the fifth grade level. The fourth grade was allowed to give definitions for the words in parts two and three orally, with the examiner recording their answers. From fifth grade on the children were asked to write out the meanings of the words. There are two disadvantages to having the children write out the definitions. In the first place, the children are not facile enough in spelling and general written expression to be able to write all they know or to make their definitions exact and clear. The duller child at the fifth and sixth grade levels may turn in a paper with only two sketchy attempts at definition written on it. If this same pupil is taken individually and asked to give oral explanations for the words he may succeed in defining five or six of the terms; he is certain to do better than his written work indicated.

In the second place, it requires much encouragement from the examiner to persuade some of the children to attempt more than one or two of the words. Some of the children were so greatly impressed by the number of unfamiliar and difficult words that they gave up on the lists as a whole and failed to attempt the ones they did know. Particularly if the student was growing at all tired toward the end of the test, it was easy for him to overlook words for which he could give at least a partial meaning when questioned specifically on those words.

For this reason we recommend that the fifth and sixth grades be treated like the fourth and be tested individually and orally on parts two and three of the test.

Figures 3 and 4 present the medians, quartiles, and ranges of scores for basic and total vocabulary at year intervals of chrono-


BASIC VOCABULARY SCORES BY
CHRONOLOGICAL AGE GROUPS
TOTAL RANGE
INTERQUARTILE RANGE
MEDIAN
VOCABULARY SCORES, IN THOUSANDS
110
100
90
80
70
60
50
40
30
20
10
6
7
8
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10
11
12
13
14
15
16
17
18
19
CHRONOLOGICAL AGE

FIGURE 3

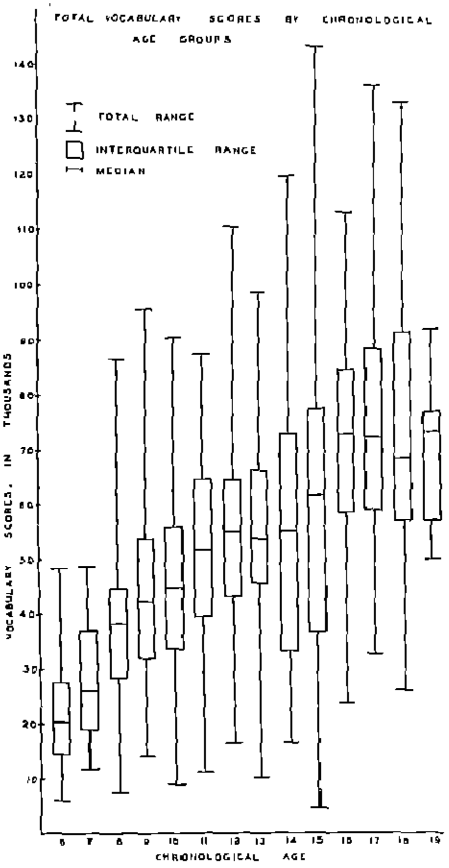

FIGURE 4

logical age which was defined in terms of the nearest birthday so *that any given year represents the midpoint of a distribution, e.g.*, a chronological age of six means ages from five years seven months to six years six months, etc. It must be noted that the sampling for these chronological age groups represents the school population and not chronological age groups at large. This caution is particularly applicable to the upper and lower limits of the distribution. The drop in the chronological age curve at the 18-year level is probably to be explained on the basis of this sampling. Those people who are 18 years old and over and who are still in high school normally may be slightly retarded and could be expected to represent the lower end of the distribution of scores at that chronological age level. The apparent rise in the curve again at the 19-year level is a chance fluctuation in that in this sampling there were only nine subjects who were that old.

TABLE 3

PERCENTAGE OF DERIVED WORDS IN TOTAL VOCABULARY AT THE DIFFERENT GRADE LEVELS

Sch. grade	Per cent	Sch. grade	Per cent
1	29	7	37
2	33	8	35
3	36	9	37
4	44	10	38
5	34	11	40
6	36	12	41

Table 3 presents the proportion of derived terms in the total vocabulary. There is a gradual increase in this proportion from first grade to twelfth. The older children not only know more words, but they are better able to handle words in general. Seashore and Eckerson's (4) study of university students showed that at that level there was a still greater difference in the number of words in the mean basic vocabulary and the mean total vocabulary. This qualitative growth in the vocabulary should be made the topic of further research.

Scores on part two, the rare words, are uniformly very low. The individual's environment and particular experience are determining factors in his knowledge of such words. It was notable that most of the older children and many of even the early elementary students in the Northbrook School knew where and what Ft. Sheridan is, as it happens to be an army training post on the lake front north of Chicago and within 10 miles of the town. Only a few of the younger pupils in the Cleveland School knew Ft. Sheridan; Niles Center is farther inland from Northbrook and is about 15 miles from Ft. Sheridan. However, at New Concord none of the children, in either the elementary or the high school, could locate Ft. Sheridan. Also an example from the derived words, the children at New Concord in the high school, many of whom come from farm homes, could explain "green manuring," which is a method of enriching the soil by plowing under leguminous crops; whereas the Northbrook High School students did not know the term.

The results of this testing also have methodological significance. It is evident from the great overlapping of scores at the different grade levels that there is no sharp break in the general ability of the children at any point in the elementary school. In general, however, for a satisfactory measurement of absolute size of vocabulary it is best to test children in the first three grades individually, allowing the child to answer the questions orally. In the fourth and fifth grades it is well to test the children in groups of not more than four or five on part one, and individually on parts two and three. From grade six up the children may be tested in groups of 20 or 30 for part one; the sixth grade being tested orally on parts two and three, seventh and eighth writing out the definitions. Through grades six, seven, and eight the examiner should read the words for the children and may suggest which words they should attempt.

At all grade levels there will be exceptional children. Some third graders could write their answers to parts two and three very well, but on the whole that age level is not able to spell and write well enough to do their best at such a task. There are also children in fourth, fifth, sixth, and even seventh and eighth grades who should be questioned orally and individually on the words on parts two and three, and even for the words on part one in order to secure a truly representative measurement of the absolute number of words which they know. More detailed directions for the giving of the tests at the different grade levels have been worked out as manuals for the Seashore-Eckerson *English Recognition Vocabulary Test.*

It was easy to secure the coöperation of the subjects in the vocabulary testing. Children in the first four grades were eager to have their turn in taking the test. The older children were interested in the test and in their scores.

It is apparent that the three schools tested in this study, on the elementary grade level at least, are not equal. The three communities are of about equal size, ranging from a population of a little over 1,000 at New Concord and Northbrook to 5,000 at Niles Center. There were greater differences in the size of the surrounding communities and in the occupations of the parents than in the size of the school communities themselves. At New Concord there are no great cities nearer than Cleveland, Ohio, and Wheeling, West

Virginia, which are respectively 100 miles and 60 miles away. City life and even town life does not affect many of these children very much. Children at Northbrook and Niles Center, on the other hand, live on lines of direct transportation to the city of Chicago and, at Niles Center particularly, are in contact with the city frequently. The parents of the children in the New Concord School include some professional men as the town is a college community, but the greater part of the children in the early elementary grades come from farm homes. The parents of the children at Northbrook are also farmers, artisans, and sub-professional men to a great extent. Niles Center is more of a residential suburb for the city and a good many of the parents commute to Chicago for their work.

Thus the differences in the scores of the three schools may be due

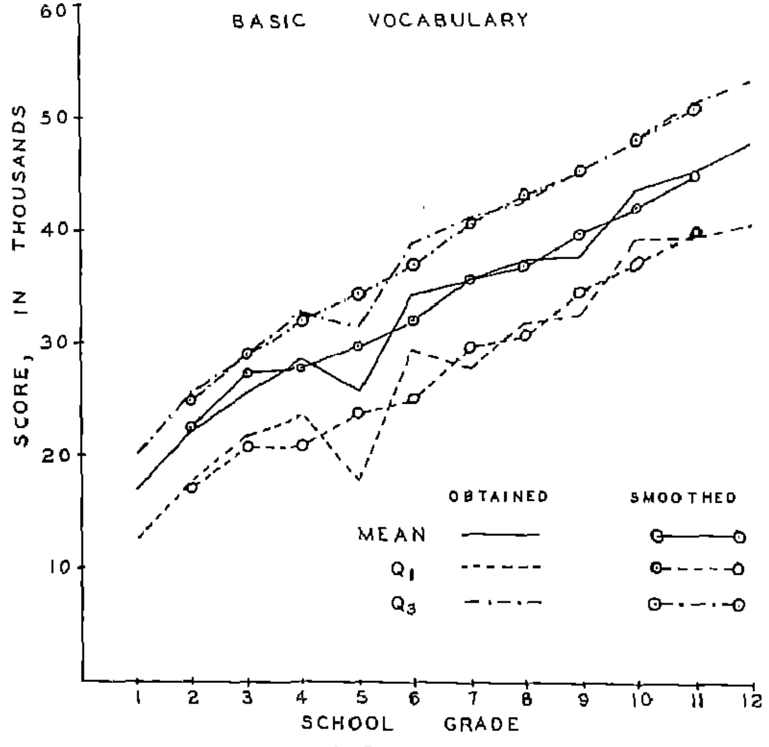

FIGURE 5

to differences in the cultural background of the pupils. It will be noted that these differences disappear at the upper grade levels. There the two schools involved sample about the same type of population, with the Northbrook High School students still having the advantage in the amount of contact with city life. It is not claimed that these three schools represent a normal sampling of American schools, but there is nothing to indicate that they are in any way atypical. Consequently it seems justifiable to average the scores at each grade level from all three schools.

The mean and quartile scores from the three schools combined

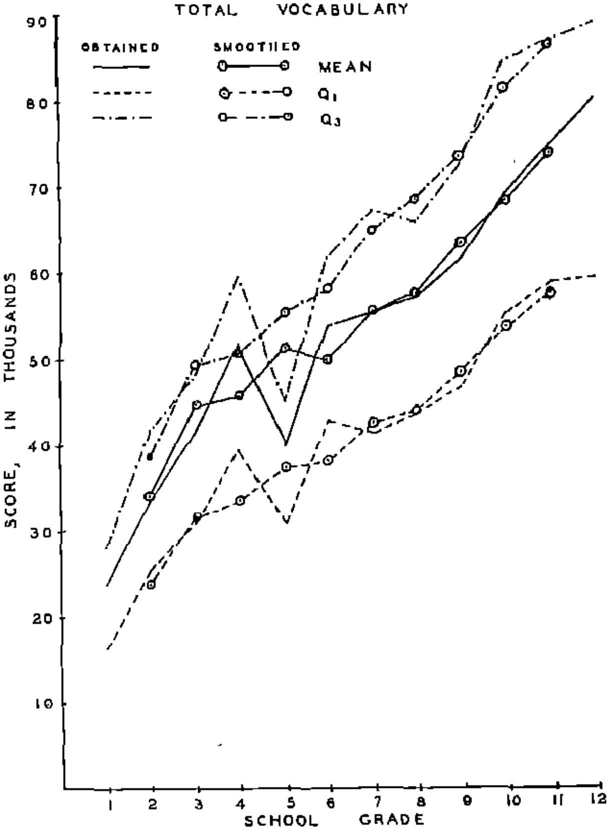

FIGURE 6

are plotted in Figures 5 and 6. Alongside these obtained means and quartiles are plotted smoothed curves, representing the score for each grade averaged with the two adjacent grades, e.g., the score at grade two on this curve represents the average of scores for grades one, two, and three. Using these two curves as a guide, another set of curves has been drawn, fitted by inspection, and shown in Figures 7 and 8. Tentative grade norms should be read from these fitted curves.

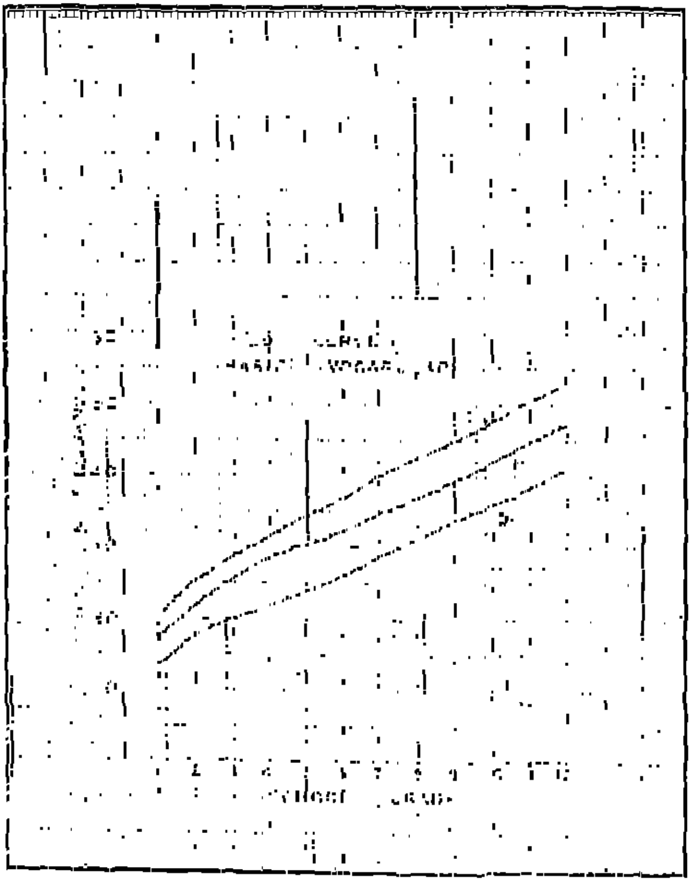

FIGURE 7

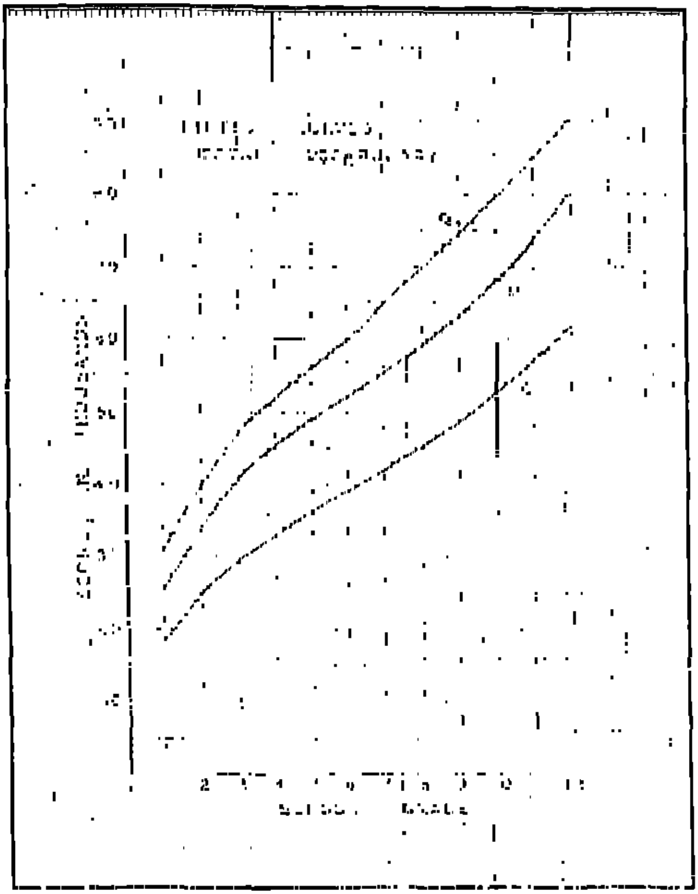

FIGURE 3

A child's score may be interpreted either in terms of the variability within his school grade or in terms of the averages of grades above or below his own. For example, the score of a fourth grader may be interpreted to mean that he ranks in the upper fourth of his class or that he has a vocabulary which is equal to the size of the average in the fifth grade.

Tentative age norms may be read from Figures 3 and 4.

A high degree of reliability in the testing is shown by the coefficients of reliability computed by correlating the scores on the even-numbered items with scores on the odd-numbered items in part one of the test.[7] Those uncorrected coefficients of reliability are shown in Table 4.

TABLE 4

School grade	$r_{\frac{11}{22}}$	*PE*
1	.73	.05
2	.75	.05
3	.69	.05
4	.75	.03
5	.94	.01
6	.91	.01
7	.95	.01
8	.92	.01
9	.93	.01
10	.87	.09
11	.86	.02
12	.76	.03

This study has shown the order of size of vocabulary for children in the elementary and high school. Many other studies of vocabulary could well follow this. Several questions concerning vocabulary growth for this same age range which remain unanswered are:

1. The factors which influence growth of vocabulary. These should be studied intensively. Suggested factors are:

   (*a*) Experience, trips, conversation
   (*b*) Wide reading
   (*c*) Systematic teaching of words—word drills, etc.
   (*d*) Analysis of words—teaching prefixes, suffixes, roots, etc.
   (*e*) Use situations—writing poetry, cross-word puzzles, cross-word lexicon, anagrams

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[7] Reliability coefficients for grades seven to twelve inclusive also were computed by correlating odd vs. even items, counting as odd and even items the alternate words attempted rather than as the words were numbered in the test. Those uncorrected coefficients of reliability are: for seventh grade, $r_{\frac{11}{22}} = .90 \pm .02$; eighth grade, $r_{\frac{11}{22}} = .92 \pm .01$; ninth grade, $r_{\frac{11}{22}} = .91 \pm .01$; tenth grade, $r_{\frac{11}{22}} = .87 \pm .02$; eleventh grade, $r_{\frac{11}{22}} = .87 \pm .02$; twelfth grade, $r_{\frac{11}{22}} = .77 \pm .03$.

It may be that these factors are of varying influence at different ages. There is evidence that direct experience is most important for children in the early grades whereas vicarious experience through reading is more valuable at the later ages.

2. There are differences between the child's various vocabularies such as those for recognition, reading, pronunciation, spelling, written use, and spoken use vocabularies. These differences need to be measured and the relationships between them studied.

3. There remains a problem of diction or selection of the *most appropriate* of several words beyond the rudimentary knowledge of any certain number of words. It should be determined how size of vocabulary relates to diction.

V. SUMMARY

In summary, the Seashore-Eckerson *English Recognition Vocabulary Test,* designed to measure individual differences in total English vocabulary,' was given to children from first grade through high school.

The test was given in two schools which had 12 grades in the school unit and in a third school which had only the first eight grades. The number of children tested at each grade level ranged from 40 at the second grade level to 114 in the ninth grade.

It was found that knowledge of words in the early grades was greatly affected by the methodology of testing and that improvement in vocabulary with age showed significant qualitative as well as quantitative changes.

Since we were interested in determining the total number of words which had any significant meaning for the child, a broad set of criteria of knowledge was adopted. Thus the child was first given an opportunity to define a word in his own terms or to illustrate its proper use in a sentence. If he was unable to meet these criteria he was then given an opportunity to demonstrate his ability to recognize the correct meaning on a four-choice multiple response test. At the earlier ages everything was read to the child to make sure that our results were not handicapped by inability to read, pronounce, or spell words. Standard, concise definitions were worked out for the alternative answer words of the multiple-choice questions and the students were instructed to ask for definitions of unfamiliar answer-words.

Grades one, two, and three were given individual oral tests exclusively; grade four was tested in small groups of four to five pupils with the examiner reading each item; while grades five and six were tested in larger groups, with the same method; grades seven through high school were tested in larger groups without the reading of the words by the examiner except as individual pupils asked for the pronunciation of certain words.

A fairly steady growth of vocabulary will be illustrated by the following figures. For grade one, the average number of basic words known was 16,900, with a range from 5,500 to 32,800. For grade twelve the average number of basic words known was 47,300, with a range from 28,200 to 73,200. For grade one the average number of words in the total vocabulary (basic plus derivative words) was

23,700, with a range from 6,000 to 48,800. For grade twelve the average number of words in the total vocabulary was 80,300, with a range from 36,700 to 136,500.

There was great overlapping of even the interquartile ranges of the different school grades. In basic vocabulary Q_1 of the eighth grade exceeded Q_3 of the first three grades. In terms of total vocabulary Q_1 of the high school seniors was higher than Q_3 of the seventh grade in the New Concord School and of the sixth grade in the Northbrook School, while Q_1 of the eighth grade exceeded Q_3 of only the first two grades.

An apparent dip in the curve for the growth of vocabulary at the fifth grade is believed to be due to the change in methodology brought about by testing in larger groups above the fourth grade, a procedure which has now been remedied. There is also some evidence for a genuine difference in ability at this level in one of the schools.

Although there were fairly large differences between the lower grades in different school systems, for the present purposes it seemed best to combine the results in a table of tentative norms, with quartile divisions, which may be interpreted either in terms of variability within the child's school grade or in terms of the averages of grades above or below his own. The same interpretations may be made in terms of chronological age.

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STEREOTYPES IN THE FIELD OF MUSICAL EMINENCE*

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ACKNOWLEDGMENTS

It has been said that the psychologist is always at the mercy of his subjects. But on the occasion of the present study the author was fortunate in being able to employ inanimate subjects—encyclopedias—for a portion of his research. However, for other parts of the study he was forced to use living materials. These included college students, who nowadays take the rôle of subject as a matter of course, and busy musicologists, who are not so accustomed to being subjected to scrutiny. To the latter the author is particularly indebted for their coöperation. He also wishes to acknowledge the aid of S. H. Matteson.

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I. INTRODUCTION

A. EMINENCE AND GENIUS CONTRASTED

In common usage, the terms *eminence* and *genius* are easily differentiated. The latter implies lasting achievement; the former does not necessarily involve this feature. But perhaps the major difference lies in the fact that eminence far more than genius is socially determined. It is conceivable that a person can be a genius without anyone else being the wiser. True, the product of his genius must be socially evaluated. Yet he will be a genius even before his achievements are evaluated. In fact there is a growing tendency to classify a man as a genius *solely* in terms of his potentialities, of his *IQ*. Now, on the other hand, to achieve any eminence whatever there must inevitably be a social judgment, an assessment by the members of some group. Moreover, the eminence of any particular person may be altered quite radically as the judges change in number and experience. At one and the same time a man may have reached the heights of eminence in one culture or subculture area and yet achieve mere notoriety in another.

B. EMINENCE RATINGS DEPEND ON STEREOTYPES

Most social judgments are based on mental pictures or stereotypes. While these may be quite realistic they are, too often for comfort, extremely unrealistic. Unfortunately there are many times when the absence of outside criteria prevents a check on their validity. Who, for example, can tell me whether or not my belief in Bach's greatness is based on valid principles? Where can I go to find a "proper" evaluation of Wagner? Indeed, in this day of relative standards we scoff at the very idea that absolute values can anywhere be found. Such standards of eminence as we can obtain, therefore, must come out of group judgments and can be expected to change from time to time. We gradually absorb them in the form of stereotypes from our teachers, from the books we read, and from many other incidental sources.

II. WAYS OF MEASURING EMINENCE

A. Polling

Up to the present the literature reveals that only three major methodologies have been employed in the attempts to measure eminence. And of these the most commonly employed is that of polling selected groups of laymen and/or "expert" judges. On occasion the judge is asked merely to name the most eminent person, or perhaps the five, six, or ten most eminent in the field in question. If he names more than one, he may or may not be asked to list them in rank order. A definition of eminence may be given the evaluator or he may be left to give the term any meaning he chooses. Often a list of names is prepared and presented with the request that the judge check the most eminent name or perhaps the five or six he considers to be most eminent. Or again he may be requested to arrange the entire list in rank order.

Fortunately it can be demonstrated that with large groups of judges the choice of a procedure to be employed becomes of relatively little importance. That is, the several polling methods yield almost identical rank orders of eminence. The choice, then, becomes a practical one to be made after a consideration of such matters as the labor necessarily involved and the degree of coöperation that can be elicited. For example, the present writer has found through many attempts at contacting judges that a maximum of coöperation is seemingly obtained when people are asked simply to list the 10 people in history who have contributed most to the particular field in question.

B. Prestige Effects

A second methodology seeks to measure eminence by indirection. The phenomenon to be evaluated is attributed to a succession of eminent people. If, for example, one wishes to study eminence in the field of painting, the procedure of Farnsworth and Misumi (11) can be followed. In this study several prints were presented to a considerable number of student judges for evaluation. One group of judges was tricked into believing that a certain painting was from the brush of Rembrandt. Another comparable group of judges viewed the *same* print while under the false impression that it had been taken from a painting by Dewing. Now as the two groups of judges possessed almost identical standards it follows that any disagreement in their evaluations of this print must be a function of the prestige difference between the eminence levels of Rembrandt and Dewing. Without necessarily being aware of the fact, many of the judges who saw Rembrandt's name associated with the print raised their evaluation on this account; on the other hand, many of those who believed Dewing to have been the painter lowered their ranking because of that artist's much lower prestige. In somewhat similar fashion, data which bear on the relative eminence of musicians can be gathered by attaching the names of several composers to a single composition. However, the methodology is far too crude for most purposes. While it can be employed to demonstrate prestige effects it cannot be made to disclose the finer differences. For this reason it will receive no further attention in the present monograph.

C. ENCYCLOPEDIA SPACE

The third methodology takes as its measure of eminence the relative amount of encyclopedia space devoted to the person in question. Presumably the musicologist who writes for the encyclopedia, or at any rate the editor in charge, allocates, perhaps without much awareness of the philosophy behind the weighting process, the available space in accordance with some notion of the comparative merits of the people whose lives he is describing. Cattell (3) at least believed this to be the case when, at the end of the last century, he took encyclopedia space as his rather indirect measure of eminence.

Quite clearly the "space" technique measures more than eminence. Notoriety certainly enters the picture in greater degree than it does when the balloting procedure is employed. For one who has promoted a notable error or fraud may achieve considerable encyclopedia space without being considered especially eminent. A notoriety factor can unmistakably be seen in the Cattell data (3) in the fact that of all the men of history Napoleon received the largest amount of encyclopedia space. This dizzy height would not have been achieved by the little emperor if the balloting of any sizable non-French population had furnished the criterion. However, in fairness to the "space" method it can be said that the notoriety problem usually does not confuse the issue to as great a degree when a smaller area of achievement is under consideration. So, if the field is limited to that of musical eminence—as is to be the practice in the present monograph—no such striking confusion will likely be found.

A slightly different objection to the "space" method concerns the seemingly excessive number of inches necessary for the adequate treatment of certain eminent persons. A composer who has lived to a ripe old age may receive more attention than one who has died young, not because he is necessarily more eminent but simply as the result of his more varied career. It is also conceivable that of two almost equally eminent musicians one may receive more encyclopedia space than his eminence can justify merely because of certain spectacular life happenings which must be recorded.

But a far more serious objection arises from the existence of bias.[1] In the balloting procedure the many different biases at least partially cancel from the sheer weight of the numbers participating. But encyclopedias are written by a relatively small number of men. The bias of the specialist is particularly dangerous where all fields of achievement are being considered simultaneously. One encyclopedia writer may regard military prowess with undue affection and musicality with a fine scorn. Thus in the Cattell study referred to above (3) the first musician to appear in the ranks of the thousand most eminent men of history was Mozart who stood well down in the list at the *ninety-third* place! Beethoven came next in *two hundred twentieth* position! But it can readily be shown by the balloting procedure—and after all this methodology is probably closer to common sense—that these low encyclopedia ratings are out of line with common belief. High rank in music cannot be equated with low general eminence among men. Fortunately when the field under consideration is limited to a smaller area, say, to music, and the measurements of several encyclopedias are pooled, the bias becomes less marked. Yet it is undoubtedly still present.

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[1] In one sense of the word all eminence ratings are biases. However, as here employed, eminence refers to the pooled opinions of the times. Bias can be defined as a particular person's disagreement with the current view. (The validity of the bias does not concern us.)

III. REASONS FOR THE PRESENT STUDY

A. Relationship between the Techniques Unknown

A combing of the literature discloses the fact that there is no information available concerning the extent of agreement between the encyclopedia space and the pooling methods of measuring eminence. Granting that the arguments given in the above paragraphs are sound, it is yet true that we know little or nothing of the magnitude of the difficulties inherent in the first mentioned method. Are they so large as to invalidate this procedure or are they so small as to be of academic interest only? If validity is assumed for the pooling technique, and this seems to be the logical step to take, then the degree of similarity with which the two procedures yield eminence ratings will measure the validity of Cattell's encyclopedia space technique. *The present study attempts to ascertain the extent* of this similarity.

B. Eminence Changes

It is obvious to any student of musicology that eminence is no absolute affair. It is well known that musicians have their peaks of popularity, their degrees of eminence which may persist for some time, decline slowly, or suddenly pass away. But this knowledge *is most superficial. Nothing is known of the rapidity of these changes,* nor indeed of the relative standing of any given musician at a particular period in history. The present study attempts to throw light on this issue.

C. Construction of Eminence Stereotypes

The writer has been especially desirous of obtaining all possible data which would help to explain the formation of the eminence stereotypes. Eminence lists are therefore to be compared with preference and familiarity lists. Rank orders compiled from the ballots of college students and others from musicologists are to be scrutinized for resemblances to each other and to certain encyclopedia lists.

IV. THE POOLING TECHNIQUE[2]

A. SUBJECTS AND PROCEDURE

Early in 1938 the then 123 members of the American Musicological Society[3] were contacted by the author with the letter given below. While a few refused to coöperate, a number could not be located, and others complied only in part with the request, 64.2 per cent gave usable answers. The letter is presented here in part:

> The Stanford laboratory has for a long time been interested in the possible approaches to the problem of eminence. At present, several of us have been checking the old Cattell ratings, and have been employing similar techniques on modern encyclopedias. We are also attempting to find whether or not other methodologies yield similar results.
>
> In attempting to further this project we would like to ask each member of the American Musicological Society to list the ten musicians of history whom he regards as having contributed most to music. We realize that this request may seem a bit ambiguous to some. *For this reason we are not asking that the names be arranged in order of magnitude, as with slightly different criteria the rank order might be altered somewhat.*

A few members quite naturally assumed that the author was holding to absolute standards from which he must be dissuaded. Several members held that there is no such thing as general eminence in music; if the term is to be employed at all it should refer to a narrower field such as violin performance. Still others grumbled at the directions, a few holding that it was impossible to list as many as 10 names, and a number maintaining with equal assurance that the list should not have been limited to 10. As a matter of fact, considerable preliminary work had convinced the author that the present directions yielded about maximum coöperation.

Later that year 150 fairly typical Stanford University sophomores, and in the autumn of 1939 a quite similar sample of 150 University of Wisconsin students, were contacted and given the order to "list the 10 musicians of history who have contributed most to music." The ballots from the two universities were combined to make up the college data.

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[2] Certain of these data and those of the next section have already been published (10) and have been reported at the 1941 meetings of the Western Psychological Association and the 1939 meetings of the American Psychological Association.

[3] It can be argued that musicologists and encyclopedia writers do not react on the basis of stereotypes as here defined. The author admits that these musicians have closer contacts than do college students with musical media. Yet he insists that the opinions of the former are based, at least in part, on mental pictures received from others and accepted with a minimum of thought.

B. DATA

The musicologists wrote in 92 names, all but one of these specialists mentioning J. S. Bach. The rank order for each name was obtained from the number of ballots it received, i.e., the number of times it was mentioned. The raw scores were then transmuted into x/σ scores. These 92 names were the ones considered in most of the remainder of the study.

The college students named only 26 of the 92 musicians given by the musicologists. The rank correlation between the two (college and musicological)[4] lists of 26 names came to .664. When the other 66 names not mentioned by the college group were given zero values and considered in the correlation, the rho value rose to .701. However, this relationship, high as it is, gives an inadequate impression of the agreement between the two groups in the choosing of the top-ranking musicians. The same four men were chosen: J. S. Bach, Beethoven, Wagner, and Mozart, and in the same order except that the musicologists placed Bach first while the college students rated Beethoven slightly higher. Farther along in the list disagreements occurred. Thus the musicologists, but not the college students, have high regard for Palestrina, Haydn, and Monteverde; the college group, but not the musicologists, think highly of Gershwin and Tschaikowsky.

Due to the relatively small size of the membership of the American Musicological Society no consistency figures could be obtained for their data. It was possible, however, to obtain several consistency figures for the data of the college group. When the lists assembled from the ballots of the Stanford and Wisconsin groups were examined separately it was found that they had 50 names in common.

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[4] The data in this monograph are of such a type that the assumptions necessary for the use of product moment correlations could not be satisfied. For this reason and because of our major interest in ranks, rho's are employed throughout. However, r's were run between several of the series. Their size was in keeping with the usual finding—they were slightly larger than the rho's.

A rank correlation of the two 50-name lists gave a value of .875. Twenty-three of the 92 names given by the musicologists appeared in both of the college lists. The rho for these was .947. In the autumn of 1940 another group of 71 Stanford sophomores was contacted and tested. This group had 74 names in common with the other Stanford group. These two lists agreed to the extent of a rho of .846. Twenty-one names from the musicological list appeared in both of the Stanford lists. These yielded a rho of .971, i.e., agreed almost perfectly.

V. THE ENCYCLOPEDIA SPACE METHOD

A. OLDER MUSICAL ENCYCLOPEDIAS

In order to keep the musical names to be studied in the several encyclopedias approximately the same it was decided to run back the historical analysis no farther than to the turn of the century. Only three encyclopedias for this earlier period were chosen, the 1904 *Grove's* (13), the 1908 *Riemann's* (5), and the 1905 *Baker's* (1). The space devoted to each of the 92 names[5] mentioned by the musicologists was measured. The three lists so obtained were paired into the six possible sets (see Table 1). When correlated these yielded rho's which can be considered as consistency or reliability values. The space measurements were transmuted for each encyclopedia into x/σ scores[6] which were then combined. In this manner was found the "Older Musical Encyclopedia"[7] composite value for each of the 92 names.

TABLE 1

INTERCORRELATIONS BETWEEN THE OLDER ENCYCLOPEDIAS

	Riemann	Baker	
1904 Grove	.763	.818	
Riemann		.914	
Grove + *Riemann* vs. *Baker*			.929
Grove + *Baker* vs. *Riemann*			.887
Baker + *Riemann* vs. *Grove*			.792

B. ENCYCLOPEDIAS OF THE 1920's

Three encyclopedias were employed for the period of the 1920's: *Pratt's* (17), the 1927 *Grove's* (13), and *Black's* (2). The space devoted to each of the same 92 names was examined separately for these encyclopedias. These values were changed in x/σ scores and combined to make the "Encyclopedias of the 1920's" composites. The separate lists when intercorrelated gave the rho's listed in Table 2. These consistencies all appear to be moderately high. The lists of the three encyclopedias were paired into all the possible

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[5] A few of the most recent names were naturally not listed.

[6] x/σ scores can be added or averaged to give composite scores.

[7] This list and the other composites have been made exclusively from encyclopedias for English speaking audiences. Foreign sources would presumably yield slightly different composites.

TABLE 2

INTERCORRELATIONS BETWEEN ENCYCLOPEDIAS OF THE 1920'S

	1927 Grove	Black
Pratt	.701	.806
Grove		.897
Pratt + *Black* vs. *Grove*		.841
Pratt + *Grove* vs. *Black*		.848
Black + *Grove* vs. *Pratt*		.741

sets which were then intercorrelated. These values proved to be of satisfactory magnitude.

C. CURRENT MUSICAL ENCYCLOPEDIAS

The encyclopedias examined to form the "Current Musical Encyclopedia" list were the *International Cyclopedia* (14), the *Oxford Companion* (19), the *Encyclopedia of Music and Musicians* (8), the *Music Lovers' Encyclopedia* (16), and *Macmillan's* (15). These were treated as were the others described above. The intercorrelations which appear in Table 3 are in the main satisfactory. To obtain further reliability figures these encyclopedias were combined into all the possible sets of 2 and 3 each. The intercorrelations were of satisfactory magnitude.

TABLE 3

INTERCORRELATIONS BETWEEN CURRENT MUSICAL ENCYCLOPEDIAS

	Int.	Oxford	Encycl.	Macmillan
Mus. L.	.761	.834	.877	.828
Int.		.771	.781	.766
Oxford			.816	.802
Encycl.				.851
Int. + *Mus. L.* + *Oxford* vs. *Encycl.* + *Macm.*			.875	
Int. + *Mus. L.* + *Encycl.* vs. *Oxford* + *Macm.*			.915	
Int. + *Mus. L.* + *Macm.* vs. *Oxford* + *Encycl.*			.913	
Int. + *Oxford* + *Macm.* vs. *Mus. L.* + *Encycl.*			.882	
Int. + *Oxford* + *Encycl.* vs. *Macm.* + *Mus. L.*			.905	
Int. + *Encycl.* + *Macm.* vs. *Oxford* + *Mus. L.*			.878	
Mus. L. + *Encycl.* + *Oxford* vs. *Int.* + *Macm.*			.914	
Mus. L. + *Encycl.* + *Macm.* vs. *Int.* + *Oxford*			.881	
Mus. L. + *Oxford* + *Macm.* vs. *Int.* + *Encycl.*			.928	
Macm. + *Oxford* + *Encycl.* vs. *Int.* + *Mus. L.*			.892	

D. MODERN LAY ENCYCLOPEDIAS

The 14th edition of *Encyclopaedia Britannica* (6), the 1936 *Encyclopedia Americana* (7), and the 1928 *New International Encyclopaedia* (18) were the units of the "Modern Lay Encyclopedia" pool. These also yielded quite respectable intercorrelational values. In order to obtain further consistency values, the *Americana* and the *New International* lists were combined and correlated with that of the *Britannica*. A rho of .829 was obtained. These three encyclopedias were combined in the other two ways which would yield single rho's. The values were found to be .825 and .884—satisfactory reliability figures.

TABLE 4

INTERCORRELATIONS BETWEEN MODERN LAY ENCYCLOPEDIAS

	Amer.	New Int.	
1936 Brit.	.794	.873	
Amer.		.809	
Amer. + *New Int.* vs. *1396 Brit.*			.829
Amer. + *1936 Brit.* vs. *New Int.*			.884
1936 Brit. + *New Int.* vs. *Amer.*			.825

E. OTHER SPACE MATERIAL STUDIED

The space devoted to each of the 92 names was also measured in a German publication, *Hugo Riemanns Musik lexikon* (20), to learn how different the picture would be from that given by the English *Riemann*. The correlation between the lists was .676, the lowest value but one of all so far reported. Data later to be presented on variability indicate that neither *Riemann* encyclopedia varies the lengths of its articles sufficiently to demonstrate fine differences in eminence.

Two histories of music were also employed for analysis. These were Combarieu's *Histoire* (4) and *A History of Music* by C. V. Stanford and C. Forsyth (21). Because of the arrangement of these books, the fact that composers were often discussed together, it was impossible to measure the space devoted to each of the 92 names. A rougher measure was therefore substituted: *the number of page mentions received in the author index.* Lists constructed by this method correlated with the list of the "Encyclopedias of the 1920's" with a rho of .671 for the *Histoire* and one of .757

for the *Stanford-Forsyth*. The size of these correlations makes it clear that the method of counting pages can be employed at least for approximating the measurements to be expected by the space method. The two history lists intercorrelated with a rho of .718.

It might be asked whether encyclopedias change from edition to edition to keep pace with eminence changes, or instead adopt a rather fixed policy of space allocation. The only policy data on musical encyclopedias this monograph presents refer to the changes in *Grove's* from the 1904 to the 1927 edition. The coefficient of correlation which fell at .870 demonstrates the extent of change. Now it might be maintained that the 92 names do not make for a fair test. To answer this objection the 409 names which appeared in both of these editions were ranked. These two longer lists correlated at .820, a value which is probably not significantly below the .870 reported above.

Possible policy changes in the *Encyclopaedia Britannica* are shown in Table 5. The 9th and 11th editions were examined in the same manner as was the current (14th). The table indicates that the period of maximum changes occurred between the publications of the 9th and 11th editions.

TABLE 5

THE ENCYCLOPAEDIA BRITANNICA

	11th	14th
9th	.768	.683
11th		.888

F. VARIABILITIES

It seems reasonable to suppose that the greater the variability of the lengths of the encyclopedia articles (relative to their averages) the finer will be the differences in eminence that can be expressed. Thus in an encyclopedia which treats all composers to articles of exactly similar length there will be no variability and consequently no differences in eminence to be measured. Fortunately all encyclopedias show variability, but in differing amounts.

From the variability data of the above table it now becomes clear why earlier it was declared that the two *Riemann* encyclopedias did not disclose fine differences in eminence. The *Oxford* is as bad as

TABLE 6
MEASURES OF V*

Name	V	Name	V	Name	V
1904 Grove	209.6	Pratt	155.5	Music Lovers'	159.4
Baker	148.6	1927 Grove	186.3	International	162.6
9th Brit.	210.7	Engl. Riemann	134.0	Oxford	134.0
11th Brit.	194.2	Black	198.0	Encyclopedia	176.5
German Riemann	119.8	Histoire	167.3	Macmillan	108.9
14th Brit.	189.1	Americana	198.5	New Intern.	200.0
		Stanford-Forsyth	141.9		

*V, the coefficient of relative variability, equals $\frac{100 \times \sigma}{\text{Mean}}$.

the English *Riemann*, and the *Macmillan* is the poorest in this respect. The lay encyclopedias, as well as *Grove's* and *Black's*, are good. As might have been anticipated there is a substantial rho, .542, between the V's and the size of the encyclopedias; that is, the larger encyclopedias tend to have the larger V's. The most striking phenomenon of Table 6 is the large range of values. It is demonstrated beyond question that the several encyclopedias are not equally fitted for the examination of eminence differences. (The V for the musicologists's list is 187.8, a value which can be rated as good. When the college list was separated into Stanford and Wisconsin sublists these latter yielded V's of 259.1 and 268.5 respectively, the largest in the set. These values are, of course, in part a function of the large number of zero values; hence they cannot be taken as valid.)

VI. COMPARISONS OF THE TWO METHODS

A. INTERCORRELATIONS

Intercorrelations were run among the four composite encyclopedia, the college, and the musicological lists. The musicologists' 92 names as usual were employed. A list with these particular names seemed proper for all except perhaps the college group who had failed to mention a large majority of them. It can be argued that whenever an encyclopedia editor or a musicologist ignored a given composer there was deliberate planning involved. The composer was considered to be unworthy. However, an omission by the college group meant, more often than not, a lack of acquaintance. Now it may well be that in measuring for eminence the reasons for the omissions should be ignored. But for the benefit of those who may believe otherwise, the correlations in which the college group are involved are presented two ways—once with the full 92 names and again with the 26 names which received at least one vote. This gesture was quite probably unnecessary as the data of Table 7 show the two sets of rho's to be very similar.

TABLE 7
INTERCORRELATIONS

	Mod. Lay.	1920's	Older	College	Musicol.
Current Mus.	.831	.861	.684	.781 (.751)	.623
Mod. Lay.		.841	.758	.718 (.782)	.602
1920's			.772	.746 (.752)	.546
Older				.631 (.638)	.580
College					.701 (.664)

( )=26 names

It can be seen from the above table that the encyclopedia composites intercorrelate quite well with each other. It is reasonable that the lowest values should be those between the oldest and the most recent encyclopedia lists. It should be noted that although the stereotypes have changed, a pattern remains even after 30 or more years.

The college and musicologist groups agree with each other somewhat less well. In fact, the college ranking agrees with the "Current Musical Encyclopedia" list as well as, if not somewhat better[8] than, it does with that of the musicologists. The musicologists' list does not agree with any of the other lists to as great a degree. But no doubt these findings should have been anticipated, at least in part. The musicologists are individualists and should not be expected to reflect popular taste to any such degree as should be true of the college students. The latter group takes information somewhat passively in stereotyped form from teachers, friends, and books. Conservatory students, on the other hand, most probably would have been found to mirror a little more closely the musicological norms. Unfortunately no data from them are available.

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[8] Critical differences between rho's are not reported as few are large

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enough to satisfy the accepted criterion of statistical significance ($3\sigma_D$). To satisfy they should approximate .15 to .18. Therefore, the reader is left free to interpret the trends as he will.

VII. EMINENCE, PREFERENCE, AND FAMILIARITY

A. Eminence and Preference

It is evident that those we consider most eminent are not necessarily the ones whose music we most prefer. Frankenstein (12), in discussing a preliminary popular report of this monograph, claims to have tested numerous students at the University of California, the University of Chicago, and Stanford University and to have found the order of preference to be: Wagner, Brahms, Franck, Debussy, R. Strauss, Puccini, and Tschaikowsky, with J. S. Bach well down the list. Presumably the possibilities were limited to "good" composers; otherwise, a jazz composer or two would probably have edged into the list.

We noted that several musicologists objected to the idea that eminence exists as a single entity. A similar and even more vigorous objection can be offered the idea that preference lies on a single continuum. Just as chicken may be preferred as an entrée and lemon pie as a dessert, so Bach may be preferred for one mood and Ravel for another. The very idea that one is to be preferred to the other may seem meaningless. Yet music texts must choose and select. And it is this weighting process, this emphasizing of one composer at the expense of another, that gives us the concept of eminence.

Another way of looking at the matter can be seen in the often heard remark: "I just *must* learn to like Bach." The intensity of this desire is in a sense a measure of the height of Bach's eminence. So it is not the present preference which is so closely related to eminence but rather a future "hoped for" preference.

B. Eminence and Familiarity

In an earlier section of the monograph it was shown that the rho's in which the college subjects were featured were quite similar, regardless of the number of names (92 or 26) mentioned. Such a finding could perhaps have been forecast had we then known the relatively high correlation which exists between familiarity and eminence. For when a check list[9] of the 92 composers was presented to the Stanford group some weeks after the eminence data had been gathered (the subjects were required merely to check all names with which they were familiar), the correlation between familiarity and eminence was found to be .838. The size of this correlation should not cause surprise for it must be obvious that eminence is in part a matter of acquaintance (with high regard added). It must be admitted that even in the field of science, eminence has been enhanced by judicious advertising! As the scientist may not be able to dupe his specialist colleagues, his eminence as rated by them may be low. But his general eminence is highly correlated with the familiarity of his name.

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[9] For another study on the familiarity with musical names see (9).

In the area of music the striking example of the effects of judicious advertising on Wagner's eminence will perhaps suffice. Wagner had behind him a most efficient group of advertisers ably headed by his wife, Cosima. Now regardless of our belief in the greatness of this man's genius every one of us who carefully reads the history of the Wagnerian era is forced to note the plans and strenuous efforts made to "put Wagner over." Without the work of his loyal staff Wagner quite likely would never have reached his present high eminence rank. Thus where advertising is strong eminence grows far more rapidly.

VIII. CHANGES IN EMINENCE

A. CATTELL'S LIST

Cattell's list of the thousand most eminent men of history (3) was assembled by measuring space in a number of encyclopedias, both American and foreign. Although the exact list employed is not now known,[10] it seems certain that earlier editions of the *Encyclopaedia Britannica* were relied upon quite heavily. Table 8 shows the first 10 names of Cattell's musical list in the order of their eminence from highest to lowest, their ranks in general eminence, and their positions in three editions of the *Encyclopaedia Britannica.*

TABLE 8*

CATTELL'S LIST AND THE ENCYCLOPAEDIA BRITANNICA

		9th Brit.		11th Brit.		14th Brit.	
Name	General Em.	Rank	x/σ	Rank	x/σ	Rank	x/σ
Mozart	93	2	3.55	5	2.34	5	2.31
Beethoven	220	7	2.27	2	4.11	2	4.45
Handel	261	5	2.87	4	3.30	3	3.93
Haydn	300	8	2.00	13	.55	15	.46
Rossini	326	13	—	18	—	26	—
Wagner	337	1	3.63	1	4.33	4	2.39
Weber	362	6	2.40	10	1.08	11	.53
Mendelssohn	404	3	3.41	6	1.49	9	.95
Palestrina	471	4	3.15	12	.64	10	.73
Bach	475	10	1.22	3	3.96	1	4.80

*The ranks in Table 8 deviate slightly from those appearing in Table 1 of (10). This slight discrepancy is due to a minor change in the treatment of photographs as encyclopedia space.

The most striking phenomenon shown by the table is the climb of Bach's prestige. Beethoven's position has also improved, but not so much. Rossini's prestige has steadily fallen. No x/σ values are given for Rossini as his name did not appear in the list of 92 mentioned by the musicologists.

B. TEMPORAL CHANGES AS SHOWN IN SEVERAL LISTS

Table 9 shows the most eminent names in each of six lists. The values are x/σ scores. The numbers in the parentheses are ranks. The four most eminent of the names in each list are starred.[11]

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[10] Personal letter from Dr. Cattell.

[11] The question might well be raised as to the effect on the relative emi-

TABLE 9

TEMPORAL CHANGES OF THE FOUR MOST EMINENT

	Older	1920's	Cur. Mus.	Mod. Lay	College	Musicol.
Bach	1.55 (10)	1.65 (8)	*2.71 (3)	*3.77 (2)	*4.08 (2)	*4.14 (1)
Beethoven	*2.96 (3)	*3.99 (1)	*3.42 (1)	*4.79 (1)	*4.74 (1)	*4.02 (2)
Wagner	*3.54 (1)	2.34 (5)	*3.01 (2)	*3.69 (3)	*3.79 (3)	*3.6[illegible] (3)
Mozart	2.48 (6)	*3.39 (2)	1.52 (6)	*2.54 (4)	*3.16 (4)	*3.18 (4)
Schubert	2.54 (5)	*2.80 (3)	*2.61 (4)	1.29 (9)	1.78 (7)	1.27 [illegible]
Mendelssohn	*3.24 (2)	*2.78 (4)	1.56 (7)	1.42 (7.5)	1.22 (9)	—.41 (43.5)
Schumann	*2.68 (4)	2.09 (6)	1.57 (5)	1.07 (10)	—.02 [illegible]	—.75 [illegible]

The story of Bach's steady improvement in eminence can be seen again in Table 9. Mendelssohn's position has become less favorable. The musicologists particularly feel these changes. In the early days of the century the most eminent musicians of history were: Wagner, Mendelssohn, Beethoven, and Schumann. During the 1920's Mozart and Schubert entered the ranks of the "great four," displacing Schumann and Wagner. The "Current Musical" list retains Beethoven and Schubert, adds Bach and Wagner, and drops Mendelssohn and Mozart. The "Modern Lay," the college, and the musicological lists, while differing among themselves as to rank order, agree in making Bach, Beethoven, Wagner, and Mozart the "great four."

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nence ranks of the omission of all names which did not appear in the musicological list of 92. The several attempts which have been made to ascertain the extent of this difficulty all make it clear that these omissions (with the exception of Gershwin) do not affect the relative positions of those highest in eminence. In the 1904 *Grove's* the only fairly eminent musicians who were neglected because of this arbitrary limiting of names *were Rossini and Spontini who achieved 11th and 12th places respectively*, Vogler and Sophr who tied with the rank of 19.5, Paganini who was found to be in 21st position, and Meyerbeer in 24th. In the later *Grove's* the following were neglected: Rossini, 15th; Boito, 19th; Spontini, 21st; Elgar, 22nd; and Vogler and Spohr tied with the rank of 24.5. In the 14th *Encyclopaedia Britannica the only important omissions were Cherubini with* the rank of 17, Elgar with a rank of 23.5; and Dvorak who stood at 25th place. The college students gave the omitted Gershwin a rank of 5.

IX. MAJOR CONCLUSIONS

1. The eminent musician may or may not be a genius. But to be eminent he must be so judged by a group of his fellows. And as standards of eminence are relative rather than absolute, the judgments employed in the evaluation process tend to be based on stereotypes. Eminence is a reflection of "what people think they should think."

2. Stereotypes in the field of musical eminence can be reliably measured by the procedure of asking subjects to list the 10 musicians of *history who are regarded as having contributed the most to music.* If two groups numbering as few as 150 each are chosen from populations of very similar culture they will agree almost perfectly on the eminence ranks they will give a list of musicians.

3. Stereotypes in the field of musical eminence can also be reliably measured by the procedure of measuring the relative amounts of *encyclopedia space devoted to the musicians in question.* The listings of several encyclopedias can be pooled to advantage. However, all encyclopedias are not equally well suited to this kind of analysis.

4. A cruder method of space analysis is possible with histories of music. This consists in the tabulation of the number of page mentions received in the author index.

5. The *polling and the encyclopedia space methods of measuring* eminence stereotypes show considerable agreement. Rho's as large as .78 have been obtained.

6. Eminence and familiarity are closely related. Eminence equals familiarity plus high regard. Eminence and present preference are not so nearly identical as are eminence and "hoped for" preference. That is, *the frequency of the popular desire to learn to like a composer's works is a measure of that composer's eminence.*

7. By the use of ranks and standard scores the temporal changes in eminence stereotypes can be plotted. The "great four" in music history now appear to be Bach, Beethoven, Wagner, and Mozart in that order. Eminence changes during this century have been large as can be shown by the fact that in the early 1900's the most eminent were considered to be Wagner, Mendelssohn, Beethoven, and Schumann, in that order. Bach in particular has enhanced his position while Mendelssohn has declined in eminence.

APPENDIX

x/σ Scores

Name	Older	1920's	Cur. Mus.	Mod. Lay	College	Musicol.
Bach, J. S.	1.35	1.65	2.71	3.77	4.08	4.14
Beethoven	2.96	3.99	3.42	4.79	4.74	4.02
Brahms	1.12	.73	1.24	1.42	1.98	1.62
Wagner	3.54	2.34	3.01	3.69	3.79	3.60
Palestrina	.53	.66	.48	.71	—.32	2.88
Mozart	2.48	3.39	1.52	2.34	3.16	3.18
Pythagoras	—.40	—.56	—.59	—.51	—.38	.07
Handel	1.55	.78	1.34	1.68	.64	1.03
Schubert	2.54	2.80	2.61	1.29	1.78	1.27
Chopin	.43	.56	1.01	1.48	1.60	.55
Strauss, R.	—.29	.33	.39	.13	*	.07
Monteverde	.11	—.31	.02	—.23	—.38	1.50
Gluck	.37	—.26	.15	.66	—.32	.13
Haydn	1.50	1.16	1.07	.44	.27	2.16
Guido D'Arezzo	—.03	—.45	—.38	—.15	—.38	.25
Lasso	.28	.05	—.12	—.10	—.38	.19
Debussy	—.62	—.12	1.25	.06	.92	1.38
Despres	—.05	—.45	—.26	—.36	—.38	.25
Berlioz	.27	.45	.96	.27	—.30	.19
Stravinsky	—.63	—.26	.44	—.41	—.04	.07
Pope Gregory	—.48	—.55	—.65	—.48	—.38	—.41
Mussorgsky	—.53	—.44	.13	—.52	—.36	.01
Schütz	0.00	—.25	—.40	—.46	—.38	—.29
Liszt	1.15	1.53	1.14	.52	.72	.01
Bruckner	—.32	—.41	—.08	—.21	—.38	—.47
Wolf	—.53	—.27	—.04	—.01	—.38	—.47
Ziehn	—.63	—.48	—.65	—.52	—.38	—.47
Rameau	.39	0.00	.14	—.23	—.38	—.11
Emperor Huang Ti	—.63	—.56	.70	—.52	—.38	—.47
Dolmetsch	—.63	—.77	—.47	—.40	—.38	—.47
Grieg	—.11	.13	.32	.13	—.11	—.47
Scott, C.	—.62	—.40	—.01	—.38	—.38	—.47
Fickenscher	—.63	—.56	—.65	—.52	—.38	—.47
Cowell	—.63	—.54	—.50	—.52	—.38	—.47
Perotinus	—.62	—.55	—.64	—.52	—.38	—.17
Landino	—.57	—.54	—.62	—.52	—.38	—.47
Praetorius	—.47	—.47	—.56	—.45	—.38	—.47
Riemann	—.17	—.32	—.59	—.49	—.38	—.41
Hucbald	—.33	—.52	—.59	—.36	—.38	—.29
Zarlino	—.16	—.43	—.54	—.30	—.38	—.41
Odington	—.56	—.53	—.65	—.52	—.38	—.47
Corelli	—.18	—.49	—.31	—.43	—.38	—.35

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[*] It was impossible to learn from an inspection of the college data the correct number of Strauss votes (a small number at best) to be given the two Strauss names. Presumably Johann was intended as the recipient in the majority of cases.

Name	Older	1920's	Cur. Mus.	Mod. Enc.	College	Musicol.
St. Ambrose	—.53	—.54	—.64	[illegible]	[illegible]	—.35
Bach, K. P. E.	—.16	—.28	—.19	[illegible]	—.35	—.29
Pergolesi	.09	—.22	—.36	.27	.38	—.37
Dufay	—.44	—.51	.49	[illegible]	.38	—.29
Helmholtz*	—.20	—.39	—.57	[illegible]	.38	—.47
Sweelinck	—.33	—.49	—.43	—.44	—.38	—.47
Weber	1.69	1.70	.62	.34	—.38	—.47
Leoninus	—.63	—.56	—.65	—.52	—.38	—.47
Mason, L.	—.50	—.42	—.42	—.46	—.38	—.47
Hastings, T.	—.64	—.52	—.65	—.52	—.38	—.47
Lowry, R.	—.63	—.56	—.68	—.52	—.38	—.47
Bradbury, W.	—.57	—.55	—.65	—.52	—.38	—.47
Doane, W.	—.63	—.56	—.68	—.52	—.38	—.47
Holden, O.	—.61	—.56	—.66	—.52	—.38	—.47
Main H.	—.63	—.56	—.68	—.47	—.38	—.47
Root, G.	—.58	—.49	—.59	—.43	—.38	—.47
Sankey, J.	—.63	—.54	—.66	—.48	—.38	—.47
Tschaikowski	.38	.52	.57	.59	1.89	—.41
Schönberg	—.58	—.14	.30	—.37	—.36	—.11
Byrd, Wm.	—.30	—.33	—.23	—.09	—.38	—.23
Couperin, F.	—.19	—.37	—.24	—.40	—.38	—.47
Scarlatti	—.10	—.14	—.30	—.25	—.38	—.41
Mahler	—.56	—.27	—.27	—.40	—.38	—.47
Casals	—.63	—.47	—.56	—.41	—.38	—.47
Kirnberger	—.36	—.46	—.62	—.52	—.38	—.47
Cristofori	—.43	—.46	—.54	—.50	—.38	—.47
Stradivarius	—.25	—.13	—.46	—.28	—.30	—.47
Dunstable	—.40	—.48	—.60	—.47	—.38	—.35
Purcell	.48	—.31	.78	—.01	—.34	—.41
Schumann	2.68	2.09	1.57	1.07	—.02	—.05
Mendelssohn	3.24	2.78	1.36	1.42	1.22	—.41
Sibelius	—.57	—.24	.46	—.32	.18	—.17
MacDowell	—.41	.40	.25	.18	—.38	—.47
Scriabin	—.59	—.31	.03	—.22	—.38	—.47
Willaert	—.36	—.48	—.49	—.49	—.18	—.29
de Okeghem	—.39	—.49	—.58	—.34	—.38	—.29
Franck	—.35	.26	.48	—.27	—.34	—.47
Glinka	.01	—.20	—.35	—.23	—.38	—.47
Aristoxenus	—.56	—.56	—.67	—.39	—.38	—.47
Marenzio	—.39	—.31	—.62	—.44	—.38	—.47
Lulli	.13	—.29	.17	—.28	—.38	—.47
Franco	—.54	—.53	—.64	—.52	—.38	—.47
Grove, Sir Geo.	—.30	—.20	—.53	—.33	—.38	—.47
Caccini	—.40	—.02	—.60	—.42	—.38	—.47
Stebbins, G.	—.63	—.56	—.70	—.45	—.38	—.47
Frescobaldi	—.27	—.51	—.56	—.38	—.38	—.47
Verdi	.57	.74	.72	.33	.85	—.11
de Machaut, G.	—.61	—.53	—.64	—.36	—.38	—.23
Le Jeune, C.	—.56	—.48	—.61	—.52	—.38	—.41
Lawes, H.	—.52	—.47	—.55	—.44	—.38	—.47

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*In cases like this, estimates have been made concerning the amount of encyclopedia space referring solely to musical achievement.

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